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TITLE: LIQUID CRYSTAL DISPLAY DEVICE AND ITS PRODUCTION

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[57] Abstract:

PROBLEM TO BE SOLVED: To obtain a liquid crystal display device, showing uniform brightness in the display screen, which is improved contrast and luminance which displays high-quality images while preventing generation of cross talk by forming columnar spacers each containing uniform density of particles, having a size which is almost the same as the thickness of the liquid crystal layer formed between a pair of substrates which constitute the liquid crystal panel. SOLUTION: Columnar spacers SP are formed on at least one of a pair of substrates. Each columnar spacer SP consists of a resin PRS containing particles RU having a size almost the same as the cell gap. The particles RU are made of spherical, spheroidal or short fiber type silica beads, polymer beads or the like. Thereby, even when the height of the resin which constitutes the columnar spacers SP is smaller than the cell gap, the desired cell gas can be maintained by the particles RU and the cell gap is made uniform. Thus, a display screen with uniform brightness can be obtd.

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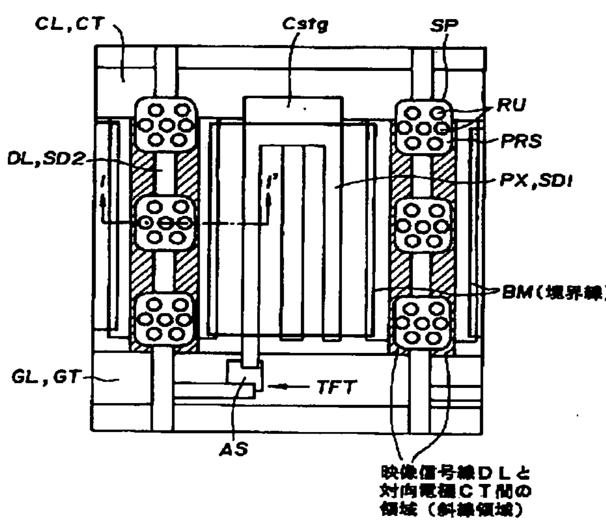
(54)【発明の名称】 液晶表示装置とその製造方法

(57)【要約】
【課題】セルギャップの不均一による表示画面内の輝度むらを防止し、輝度の低下、クロストークの発生を防止する。
【解決手段】所望のセルギャップを規制する粒径の粒子ＲＵを分散した樹脂ＰＲＳをベースフィルムに積層した転写シートを用いてカラーフィルタ基板またはアクティブマトリクス基板の何れか一方に転写して形成した粒子ＲＵ入りの柱状スペーサＳＰを備えた。

図１



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【特許請求の範囲】

【請求項１】少なくとも一方が透明な一対の基板と、前記一対の基板の一方に形成されたカラー表示のための色の異なる少なくとも２種類以上のカラーフィルタおよび各カラーフィルタの間に介在させたブラックマトリクスと、前記一対の基板上に形成された電極群と、前記一対の基板の間に誘電異方性を有する液晶層およびこの液晶層を構成する液晶組成物の分子配列を所定の方向に配列させるための配向制御層とを有する液晶パネルと、前記電極群に駆動電圧を印加するための駆動手段とを具備し、

前記一対の基板の少なくとも一方に、所望の液晶層の厚さにほぼ等しい大きさの粒子をほぼ均一に分散させた樹脂からなる柱状スペーサを有することを特徴とする液晶表示装置。

【請求項２】前記柱状スペーサに含む粒子の径が前記液晶パネルのブラックマトリクス間に形成される画素の中央部分の液晶層の厚さより小であることを特徴とする請求項１に記載の液晶表示装置。

【請求項３】前記柱状スペーサの誘電率または導電率が前記液晶層を構成する液晶組成物のそれよりも高く、前記柱状スペーサを前記ブラックマトリクスで隠される位置に配置した前記信号配線と共通配線との間の一部に形成したことを特徴とする請求項１または２に記載の液晶表示装置。

【請求項４】少なくとも一方が透明な一対の基板と、前記一対の基板の一方に形成されたカラー表示のための色の異なる少なくとも２種類以上のカラーフィルタおよび各カラーフィルタの間に介在させたブラックマトリクスと、前記一対の基板のうちの他方の基板の上に形成された信号配線と共通配線を含む電極群と、所定の間隔で対向させた前記一対の基板の間に誘電異方性を有する液晶層およびこの液晶層の分子配列を所定の方向に配列させるための配向制御層と、前記一対の基板の少なくとも一方に、所望の液晶層の厚さにほぼ等しい大きさの粒子を密度均一に分散させた樹脂からなる柱状スペーサとを有する液晶パネルと、

前記一対の基板のそれぞれに偏光軸を交差させて積層された偏光板、および前記電極群に駆動電圧を印加するための駆動手段とを具備した液晶表示装置の製造方法であって、

ベースフィルムの表面に前記所定の間隔にほぼ等しい粒径の粒子を混入した感光性樹脂層を積層した感光性転写シートの前記感光性樹脂層側を前記一対の基板を構成する一方の基板に対向させて貼り合わせ、

前記柱状スペーサの形成位置に対応した開口パターンを有するマスクを介して前記感光性樹脂層側を露光し現像して、露光された部分を残して非露光部分の感光性樹脂層を除去することにより、前記液晶層の厚さにほぼ等しい大きさの粒子がほぼ均一に分散した樹脂からなる柱状スペーサを形成することを特徴とする液晶表示装置の製造方法。

【請求項５】少なくとも一方が透明な一対の基板と、前記一対の基板の一方に形成されたカラー表示のための色の異なる少なくとも２種類以上のカラーフィルタおよび各カラーフィルタの間に介在させたブラックマトリクスと、前記一対の基板のうちの他方の基板の上に形成された信号配線と共通配線を含む電極群と、所定の間隔で対向させた前記一対の基板の間に誘電異方性を有する液晶層およびこの液晶層の分子配列を所定の方向に配列させるための配向制御層と、前記一対の基板の少なくとも一方に、所望の液晶層の厚さにほぼ等しい大きさの粒子を密度均一に分散させた樹脂からなる柱状スペーサとを有する液晶パネルと、

前記一対の基板のそれぞれに偏光軸を交差させて積層された偏光板、および前記電極群に駆動電圧を印加するための駆動手段とを具備した液晶表示装置の製造方法であって、

ベースフィルムの表面に前記所定の間隔にほぼ等しい粒径の粒子を混入した熱溶着樹脂層を積層してなる熱転写シートの前記熱溶着樹脂層側を前記一対の基板を構成する一方の基板に対向させて貼り合わせ、

前記熱転写シートの前記柱状スペーサの形成位置に対応した部分を選択的に加熱し、加熱された部分のみを当該基板に融着させ、非加熱部分と共に前記熱転写シートを除去することにより、前記液晶層の厚さにほぼ等しい大きさの粒子がほぼ均一に分散した樹脂からなる柱状スペーサを形成することを特徴とする液晶表示装置の製造方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、液晶表示装置に係り、特に液晶層を構成する液晶組成物を封止する一対の基板間の距離を一定に保つための新規な構成のスペーサを備えた液晶表示装置とその製造方法に関する。

【０００２】

【従来の技術】ノート型コンピュータやコンピュータモニター用の高精細かつカラー表示が可能な表示デバイスとして液晶表示装置が広く採用されている。

【０００３】この種の液晶表示装置は、基本的には少なくとも一方が透明なガラス等からなる少なくとも２枚の基板の対向間隙に液晶組成物を挟持した所謂液晶パネルを構成し、上記液晶パネルの基板に形成した画素形成用の各種電極に選択的に電圧を印加して所定画素の点灯と消灯を行う形式（単純マトリクス型液晶表示装置）、上記各種電極と画素選択用のアクティブ素子を形成してこのアクティブ素子を選択することにより所定画素の点灯と消灯を行う形式（アクティブマトリクス型液晶表示装置）とに大きく分類される。

【０００４】アクティブマトリクス型液晶表示装置は、

そのアクティブ素子として薄膜トランジスタ（ＴＦＴ）を用いたものが代表的である。薄膜トランジスタを用いた液晶表示装置は、薄い軽量かつブラウン管に匹敵する高画質であるということから、ＯＡ機器の表示端末用モニターとして広く普及している。

【０００５】この液晶表示装置の表示方式には、液晶の駆動方法の相違から大別して次の２通りがある。その１つは、透明電極が構成された２枚の基板で液晶組成物を挟み込み、透明電極に印加された電圧で動作させ、透明電極を透過し液晶組成物の層に入射した光を変調して表示する方式であり、現在普及している製品のほとんどがこの方式を採用している。

【０００６】また、もう１つは、同一基板上に構成した２つの電極の間の基板面にほぼ平行に形成した電界により液晶を動作させ、２つの電極の隙間から液晶組成物の層に入射した光を変調して表示する方式であり、視野角が著しく広いという特徴を持ち、アクティブマトリクス型液晶表示装置として極めて有望な方式である。この方式の特徴に関しては、例えば特表平５－５０５２４７号公報、特公昭６３－２１９０７号公報、特開平６－１６０８７８号公報等の文献に記載されている。以下、この方式の液晶表示装置を横電界方式の液晶表示装置と称する。

【０００７】図１４は横電界方式の液晶表示装置で形成される電界を説明する要部断面図である。この液晶表示装置は一方の基板ＳＵＢ１上に映像信号線ＤＬ、対向電極ＣＴ、画素電極ＰＸが形成され、これらの上層に成膜された保護膜ＰＳＶおよび液晶組成物ＬＣの層との界面に形成された配向制御層ＯＲＩ１を有する。また、他方の基板ＳＵＢ２上にブラックマトリクスＢＭで区画されたカラーフィルタＦＩＬ、これらの上層を覆ってカラーフィルタやブラックマトリクスの構成材が液晶層ＬＣを構成する液晶組成物（以下、単に液晶とも言う）に影響を及ぼさないように成膜されたオーバーコート層ＯＣ、および液晶ＬＣの層との界面に形成された配向制御層ＯＲＩ２を有している。

【０００８】一方の基板ＳＵＢ１上にあるＧＩとＡＯＦは絶縁膜、映像信号線ＤＬは導電膜ｄ１とｄ２の２層からなり、対向電極ＣＴは導電膜ｇ１からなり、画素電極ＰＸは導電膜ｇ２からなる。

【０００９】なお、一対の基板ＳＵＢ１とＳＵＢ２の間の距離（液晶組成物の層の厚み、または間隔：セルギャップ）は両基板の間に球状のスペーサ（図示せず）を分散配置して所定値に設定するのが一般的である。基板ＳＵＢ１と基板ＳＵＢ２の外面にはそれぞれ偏光板ＰＯＬ１、ＰＯＬ２が設置されている。

【００１０】また、横電界方式の液晶表示装置とは関連していないが、このような球状のスペーサに代えてカラーフィルタ基板の保護膜に円錐状のスペーサを基板に固定的に形成し、あるいはカラーフィルタ層を積層して円柱状のスペーサを固定的に形成したものが特開平９－７３０８８号公報に開示されている。

【００１１】上記特開平９－７３０８８号公報に開示の発明では、球状のスペーサの場合、スペーサ周辺部からの光漏れによるコントラストの低下や、スペーサを基板上に散在させる工程でスペーサが不均一に配置されて表示不良を起こすという問題点を解消するため、スペーサを基板に固定的に形成するようにしている。

【００１２】また、基板間の間隔を保持するスペーサの形成方法として、ベースフィルムに感光性樹脂を塗布した感光性シートを基板に積層し、マスクを介した露光と現像を含むフォトリソ工程を用いるものが特開平７－３２５２９８号公報に開示されている。これは、スペーサの膜厚を均一にして色むらを防止するものである。

【００１３】

【発明が解決しようとする課題】本発明が解決しようとする課題は二つある。その一つは、スペーサを基板に対して固定的に形成した液晶表示装置における課題である。以後、このように固定的に形成されたスペーサを特に柱状スペーサと称す。

【００１４】スペーサは、セルギャップを均一にする目的で形成されるものであるため、柱状スペーサの膜厚の均一化が要求される。そのため、例えば、前記の特開平７－３２５２９８公報では、あらかじめベースフィルムに均一な膜厚で感光性樹脂を形成した感光性シートを基板に積層し、フォトリソ工程を経て柱状スペーサを作成している。

【００１５】この方法は、スピンコート法のように感光性樹脂を基板に塗布する方法に比べれば膜厚の均一性の面で優れていると考えられる。しかし、感光性シートを積層後のフォトリソ工程において、露光光の照射強度の面内分布の均一性や現像工程での面内不均一性等によって、基板面内および各基板毎での柱状スペーサの膜厚にばらつきが生じてしまう。そのため、セルギャップの不均一による輝度むらが発生する。

【００１６】また、液晶表示装置の製造にあたり、スペーサの機械的性質が重要になる。液晶表示装置の基板表面は平坦ではなく、微小な（１μｍ以下）段差がある。スペーサの膜厚が均一でも、スペーサが配置される部分の段差のばらつきがあるため、セルギャップを均一にするには、スペーサを基板間で押しつぶすか、あるいは基板上の構成層内にめり込ませる必要がある。したがって、柱状スペーサにも球状スペーサと同等な弾性、硬さ等の特性が要求される。しかし、感光性樹脂等の有機物からなる柱状スペーサに、ガラス、シリカ等の無機質系球状スペーサやプラスチック系球状スペーサと同等の機械的性質を要求することは困難である。

【００１７】本発明が解決しようとする課題の二つめは、横電界方式の液晶表示装置における画素設計に関する事項である。従来技術のように、電極間の距離を大き

くすることや、ブラックマトリクスＢＭの光学濃度を高くすることには次のような問題がある。

【００１８】映像信号線ＤＬと対向電極ＣＴまたは映像信号線ＤＬと１画素電極ＰＸの電極間の電界強度を小さくするために電極間の距離を広げると、表示画素領域が狭くならざるを得ず、開口率の低下による輝度の低下や消費電力の増加を招く。

【００１９】一方、ブラックマトリクスＢＭの光学濃度を高めるためには次のような問題がある。横電界法式の液晶表示装置では、ブラックマトリクスＢＭが高抵抗である必要がある（例えば、特開平９－４３５８９号公報）。ブラックマトリクスＢＭの電気特性は、基板にほぼ平行な横電界の形成に影響し、ブラックマトリクスＢＭの抵抗が低いと理想的な横電界が形成されず、輝度の低下、コントラストの低下、および視野角が狭くなる、等の問題が生じる。

【００２０】ブラックマトリクスＢＭを高抵抗にするには、顔料分散型感光性樹脂を使用するのが望ましい。このとき、ブラックマトリクスＢＭの光学濃度を高くしようとして感光性樹脂中の顔料濃度比を大きくすると、樹脂濃度が下がるためにフォトリソ工程のプロセス性が悪化する。具体的には、解像度が低下、現像マージンが低下、顔料残渣が発生し易い等、の問題が生じる。

【００２１】また、ブラックマトリクスＢＭの膜厚を厚くして光学濃度を高くしようとした場合は、カラーフィルタの平坦性が悪化し、配向制御層ＯＲＩ２のラビング性の劣化やセルギャップの均一化が困難となり、応答速度の悪化等の表示品質不良を招く。

【００２２】本発明は上記二つの課題を解決することにあり、その第１の目的は、表示画面内の輝度を均一化し、また、開口率を低下させることなく、かつ比較的低い光学濃度のブラックマトリクスを使用してもコントラストた輝度の低下、クロストークの発生がない液晶表示装置を提供することにある。

【００２３】そして、本発明の第２の目的は、上記液晶表示装置の製造方法を提供することにある。

【００２４】

【課題を解決するための手段】上記第１の目的を達成するため、本発明は、液晶パネルを構成する一対の基板の間に形成される液晶層の厚さにほぼ等しい大きさの粒子を各均一な密度で含む柱状スペーサを具備させた点に特徴を有する。

【００２５】本発明の第一の目的を達成するための典型的な構成を列挙すれば、下記（１）～（３）に記載のとおりである。すなわち、

（１）少なくとも一方が透明な一対の基板と、前記一対の基板の一方に形成されたカラー表示のための色の異なる少なくとも２種類以上のカラーフィルタおよび各カラーフィルタの間に介在させたブラックマトリクスと、前記一対の基板上に形成された電極群と、前記一対の基板の間に誘電異方性を有する液晶層およびこの液晶層を構成する液晶組成物の分子配列を所定の方向に配列させるための配向制御層とを有する液晶パネルと、前記電極群に駆動電圧を印加するための駆動手段とを具備し、前記一対の基板の少なくとも一方に、所望の液晶層の厚さにほぼ等しい大きさの粒子をほぼ均一に分散させた樹脂からなる柱状スペーサを設けた。

【００２６】この構成としたことにより、表示画面内の輝度が均一化され、コントラストや輝度の低下、さらにクロストークの発生がない液晶表示装置が得られる。

【００２７】（２）（１）における前記柱状スペーサに含む粒子の径を前記液晶パネルのブラックマトリクス間に形成される画素の中央部分の液晶層の厚さより小とした。

【００２８】この構成としたことにより、表示画面内の輝度が均一化され、また、開口率も低下せずにコントラストや輝度の低下、さらにクロストークの発生がない液晶表示装置が得られる。

【００２９】（３）（１）または（２）における前記柱状スペーサの誘電率または導電率を前記液晶層を構成する液晶組成物のそれよりも高く、前記柱状スペーサを前記ブラックマトリクスで隠される位置に配置した前記信号配線と共通配線との間の一部に形成した。

【００３０】この構成としたことにより、表示画面内の輝度が均一化され、また、開口率も低下せずに比較的低い光学濃度のブラックマトリクスを使用してもコントラストや輝度の低下、さらにクロストークの発生がない液晶表示装置が得られる。

【００３１】上記第２の目的を達成するため、本発明は、液晶パネルを構成する一対の基板の間に形成される液晶層の厚さにほぼ等しい大きさの粒子を各均一な密度で含む柱状スペーサを具備させた点に特徴を有する。

【００３２】本発明の第２の目的を達成するための典型的な構成を列挙すれば、下記（４）、（５）に記載のとおりである。すなわち、

（４）少なくとも一方が透明な一対の基板と、前記一対の基板の一方に形成されたカラー表示のための色の異なる少なくとも２種類以上のカラーフィルタおよび各カラーフィルタの間に介在させたブラックマトリクスと、前記一対の基板のうちの他方の基板の上に形成された信号配線と共通配線を含む電極群と、所定の間隔で対向させた前記一対の基板の間に誘電異方性を有する液晶層およびこの液晶層の分子配列を所定の方向に配列させるための配向制御層と、前記一対の基板の少なくとも一方に、所望の液晶層の厚さにほぼ等しい大きさの粒子を密度均一に分散させた樹脂からなる柱状スペーサとを有する液晶パネルと、前記一対の基板のそれぞれに偏光軸を交差させて積層された偏光板、および前記電極群に駆動電圧を印加するための駆動手段とを具備した液晶表示装置の製造方法であって、ベースフィルムの表面に前記所定の

間隔にほぼ等しい粒径の粒子を混入した感光性樹脂層を積層した感光性転写シートの前記感光性樹脂層側を前記一対の基板を構成する一方の基板に対向させて貼り合わせ、前記柱状スペーサの形成位置に対応した開口パターンを有するマスクを介して前記感光性樹脂層側を露光し現像して、露光された部分を残して非露光部分の感光性樹脂層を除去することにより、前記液晶層の厚さにほぼ等しい大きさの粒子がほぼ均一に分散した樹脂からなる柱状スペーサを形成する。

【００３３】この製造方法を用いたことにより、表示画面内の輝度が均一化され、開口率も低下せず、比較的低い光学濃度のブラックマトリクスを使用してもコントラストや輝度の低下、さらにクロストークの発生がない液晶表示装置を製造することができる。

【００３４】（５）少なくとも一方が透明な一対の基板と、前記一対の基板の一方に形成されたカラー表示のための色の異なる少なくとも２種類以上のカラーフィルタおよび各カラーフィルタの間に介在させたブラックマトリクスと、前記一対の基板のうちの他方の基板の上に形成された信号配線と共通配線を含む電極群と、所定の間隔で対向させた前記一対の基板の間に誘電異方性を有する液晶層およびこの液晶層の分子配列を所定の方向に配列させるための配向制御層と、前記一対の基板の少なくとも一方に、所望の液晶層の厚さにほぼ等しい大きさの粒子を密度均一に分散させた樹脂からなる柱状スペーサとを有する液晶パネルと、前記一対の基板のそれぞれに偏光軸を交差させて積層された偏光板、および前記電極群に駆動電圧を印加するための駆動手段とを具備した液晶表示装置の製造方法であって、ベースフィルムの表面に前記所定の間隔にほぼ等しい粒径の粒子を混入した熱溶着樹脂層を積層してなる熱転写シートの前記熱溶着樹脂層側を前記一対の基板を構成する一方の基板に対向させて貼り合わせ、前記熱転写シートの前記柱状スペーサの形成位置に対応した部分を選択的に加熱し、加熱された部分のみを当該基板に融着させ、非加熱部分と共に前記熱転写シートを除去することにより、前記液晶層の厚さにほぼ等しい大きさの粒子がほぼ均一に分散した樹脂からなる柱状スペーサを形成する。

【００３５】この製造方法を用いたことにより、表示画面内の輝度が均一化され、また、開口率も低下せずに比較的低い光学濃度のブラックマトリクスを使用してもコントラストや輝度の低下、さらにクロストークの発生がない液晶表示装置を製造することができる。

【００３６】なお、本発明は、上記の構成に限定されるものではなく、一対の基板のそれぞれに画素選択用の電極を備えて、当該一対の基板に垂直な方向に電界を形成して液晶層を構成する液晶組成物の配向方向を制御する所謂縦電界方式のアクティブマトリクス型液晶表示装置、あるいは単純マトリクス型の液晶表示装置にも適用できると共に、製造方法はその他微小な間隙を設定する必要のある各種の表示装置にも同様に適用できる。

【００３７】また、本発明は、特許請求の範囲に記載された技術思想を逸脱することなく、種々の偏光が可能である。

【００３８】

【発明の実施の形態】以下、本発明の実施の形態について、実施例の図面を参照して詳細に説明する。

【００３９】図１は本発明に係る液晶表示装置の第１実施例である横電界方式アクティブマトリクス型液晶表示装置を構成する液晶パネルの画素付近の構成を模式的に説明する要部平面図、図２は図１の１－１’線に沿った要部断面図である。

【００４０】なお、図１、図２において前記図１４と同一符号は同一機能部分に対応し、一対の基板ＳＵＢ１とＳＵＢ２の間に配置される各種の電極や各構造膜は、柱状スペーサＳＰとその中に含まれる粒子ＲＵを除いて図１４と同様である。

【００４１】すなわち、図１において、ＤＬは映像信号線、ＳＤ２は映像信号線から延びるドレイン電極、ＣＬは対向電圧信号線、ＣＴは対向電圧信号線と同一の対向電極、ＰＸは画素電極、ＳＤ１は画素電極と同一のソース電極、Ｃｓｔｇは蓄積容量、ＧＬは走査信号線、ＧＴは走査電極と同一のゲート電極、ＢＭはブラックマトリクス（画素部開口の境界線で示す）、ＴＦＴは薄膜トランジスタ、ＳＰは柱状スペーサ、ＰＲＳは樹脂、ＲＵは粒子である。なお、図１において斜線で示した部分は映像信号線ＤＬと対向電極ＣＴ間の領域を表す。

【００４２】また、図２において、ＳＵＢ１は一方の基板（アクティブマトリクス基板またはＴＦＴ基板）、ＳＵＢ２は他方の基板（カラーフィルタ基板）、ＧＩはゲート絶縁膜、ＰＳＶはパッシベーション層（保護膜）、ＯＲＩ１は一方の基板側の配向膜（配向制御層）、ＬＣは液晶層、ＯＲＩ２は他方の基板側の配向膜（配向制御層）、ＯＣはオーバーコート層（平滑層）、ＦＩＬはカラーフィルタ、ＢＭはブラックマトリクスを示す。

【００４３】そして、ＲＵは柱状スペーサＳＰを構成する樹脂ＰＲＳに含まれる粒子、ＤＬ（ｄ１，ｄ２）は映像信号線、ＣＴ（ｇ１）は対向電極、ＰＸ（ｇ２）は画素電極、ＡＯＦはアルミ酸化膜からなる絶縁層である。なお、上記括弧内のｄ１，ｄ２，ｇ１，ｇ２はそれらの配線あるいは電極を形成する導体層を示す。

【００４４】一対の基板ＳＵＢ１とＳＵＢ２で各外側に設置されたＰＯＬ１，ＰＯＬ２は偏光板である。

【００４５】柱状スペーサＳＰは、樹脂ＰＲＳの内部にセルギャップとほぼ大きさの等しい粒子ＲＵを含んだ構造となっている。粒子ＲＵの材料は、シリカビーズ、ポリマービーズ等の球形状あるいは楕円球形状、あるいは短ファイバー形状などの非球形（非楕円球形）であってもよい。さらに、透明な粒子に限らず黒色粒子としてもよい。

【００４６】柱状スペーサＳＰに粒子ＲＵを含ませたことにより、仮に柱状スペーサＳＰを構成する樹脂部分の高さがセルギャップよりも小さい場合でも柱状スペーサＳＰ内の粒子ＲＵによって所望のセルギャップを確保できる。したがって、セルギャップは均一となり、一様な輝度の表示画面を得ることができる。

【００４７】また、柱状スペーサＳＰの機械的性質に粒子ＲＵの機械的性質が加わるため、球状スペーサを用いた場合に近似した機械的性質をもつスペーサを得ることが可能となる。

【００４８】本実施例では、図２に示したように、柱状スペーサＳＰをカラーフィルタ基板（他方の基板ＳＵＢ２）側に形成してあるが、アクティブマトリクス基板（一方の基板ＳＵＢ１）側に形成してもよい。

【００４９】柱状スペーサＳＰは、図１に示したように、映像信号線ＤＬと対向電極ＣＴの間の領域（図１中の斜線領域）を覆うように配置してある。

【００５０】本実施例では、図１に示したように、一画素あたりの柱状スペーサＳＰの個数を６個、柱状スペーサＳＰ内に含む粒子ＲＵの数を７個としてあるが、これは一例であって、上記の個数、数は任意である。また、６個の柱状スペーサＳＰをほぼ等間隔で配置してあるが、これに限るものではなく、千鳥足状あるいはランダムに配置してもよい。

【００５１】また、柱状スペーサＳＰの平面形状は、図示したほぼ四角形に限らず、その他の形状、例えば、円形、楕円形、菱型などでもよい。

【００５２】なお、柱状スペーサＳＰ内に含む粒子ＲＵは一個以上であればよく、複数個を含ませる場合は柱状スペーサＳＰの平面形状における単位面積あたりにほぼ均一な数とし、またその分散密度も均一に分散させた方が望ましい。

【００５３】この実施例により、映像信号線ＤＬと対向電極ＣＴ間の領域からの不所望な光抜けを防止できる。以下、この理由について説明する。

【００５４】映像信号線ＤＬＬＣは映像信号線ＤＬと対向電極ＣＴ間の一部にしか存在しない。すなわち、柱状スペーサＳＰの無い部分にしか液晶層ＬＣは存在しない。液晶ＬＣが駆動されることによって光の透過率が変化する訳であるから、液晶ＬＣが存在する領域が少なくなれば光透過率の変化する領域も少なくなり、映像信号線ＤＬと対向電極ＣＴ間からの光透過量は減少する。

【００５５】したがって、柱状スペーサＳＰが無い場合に比較してブラックマトリクスＢＭの光学濃度への要求値を低減することができる。さらに、柱状スペーサＳＰの誘電率、または導電率が液晶ＬＣのそれよりも高いと、電界が液晶ＬＣよりも柱状スペーサＳＰに形成され易い。したがって、これら電極間（映像信号線ＤＬと対向電極ＣＴ間）の電界によって液晶ＬＣが駆動され難くなる。このため、柱状スペーサＳＰが無い部分でも遮光し易くなる。

【００５６】柱状スペーサＳＰを構成する樹脂には、一般に紫外線硬化型感光性樹脂が使用されるため、上記した誘電率特性や導電率特性を所望の値に制御することは難しい。本実施例では、柱状スペーサＳＰ内に含ませる粒子ＲＵの電気的特性を利用して柱状スペーサＳＰ全体の電気的特性を制御するようにした。

【００５７】柱状スペーサＳＰの誘電率および導電率を液晶のそれよりも大きくする場合は、例えば粒子ＲＵの内部または表面にカーボンブラックや金属粒子を混入または付着させて使用する。

【００５８】なお、本実施例では、柱状スペーサＳＰはカラーフィルタ基板（他方の基板ＳＵＢ２）上に形成してあるが、アクティブマトリクス基板（一方の基板ＳＵＢ１）上に形成してもよいことは前記したとおりである。

【００５９】本実施例により、コントラストや輝度が向上し、クロストークの発生が防止され、高品質の画像表示の液晶表示装置を得ることができる。

【００６０】図３は本発明に係る液晶表示装置の第２実施例である横電界方式アクティブマトリクス型液晶表示装置を構成する液晶パネルの画素付近の構成を模式的に説明する要部平面図である。図１と同一符号は同一機能部分に対応する。

【００６１】本実施例は、第１実施例において隣接する画素間に形成する柱状スペーサＳＰをそれぞれ複数個としたものに対し、隣接画素間で各一個の堤形状としたものである。その他の構成は第１実施例と同様である。

【００６２】すなわち、柱状スペーサＳＰは、画素電極ＰＸが配置される画素領域の各隣接部分に位置する映像信号線ＤＬと対向電極ＣＴ間の領域にそれぞれ堤形状に形成してある。この柱状スペーサＳＰ内に含まれる粒子ＲＵは単位面積あたり略同数となるように均一に分散される。また、この粒子の分散密度も柱状スペーサＳＰの全域で均一となるようにするのが望ましい。

【００６３】この実施例によっても、映像信号線ＤＬと対向電極ＣＴ間の領域からの不所望な光抜けを防止でき、その理由も上記第１実施例で説明したとおりである。

【００６４】次に、本発明による液晶表示装置の製造方法、すなわち柱状スペーサＳＰの形成方法の実施例を説明する。

【００６５】図４は本発明による液晶表示装置の製造方法を説明する柱状スペーサ形成用の転写シートの第１例を説明する模式断面図である。

【００６６】ＴＦＳは転写シートであり、ベースフィルムＢＳＦにシリカの粒子ＲＵを均一に分散して配置させた感光性の樹脂層ＰＲＳを積層した感光転写シート、またはベースフィルムＢＳＦにシリカの粒子ＲＵを分散して配置させた熱溶着性の樹脂層ＴＲＳを積層した熱転写

シートである。

【００６７】図５は本発明による液晶表示装置の製造方法を説明する柱状スペーサ形成用の転写シートの第２例を説明する模式断面図である。

【００６８】転写シートＴＦＳは、ベースフィルムＢＳＦにシリカの粒子ＲＵを必要個所すなわち基板上の柱状スペーサＳＰが形成される部分のみに分散して配置させた感光性の樹脂層ＰＲＳを積層した感光転写シート、またはベースフィルムＢＳＦにシリカの粒子ＲＵを必要個所のみに分散して配置させた熱融着性の樹脂層ＴＲＳを積層した熱転写シートである。

【００６９】図６は本発明による液晶表示装置の製造方法を説明する柱状スペーサ形成用の転写シートの第３例を説明する模式断面図である。

【００７０】転写シートＴＦＳは、ベースフィルムＢＳＦにシリカの粒子ＲＵを均一に分散して配置させた感光性の樹脂層ＰＲＳを離型層ＳＥＰＬを介して積層した感光性転写シート、またはベースフィルムＢＳＦにシリカの粒子ＲＵを分散して配置した熱融着性の樹脂層ＴＲＳを熱融着防止層ＡＴＡＬを介して積層した熱転写シートである。

【００７１】次に、上記の転写シートＴＦＳを用いた本発明の液晶表示装置の製造方法について説明する。

【００７２】図７は図４で説明した感光性転写シートを用いた柱状スペーサの形成方法を含むカラーフィルタ基板の製造方法の第１実施例を説明する概略工程図であり、工程（１）～（４）の順に処理される。すなわち、

（１）カラーフィルタ基板ＳＵＢ２は厚さが０．７ｍｍまたは１．１ｍｍのガラス基板であり、この基板ＳＵＢ２上に黒色の感光性樹脂を塗布し、ブラックマトリクスの配置パターンに対応した所定の開口パターンを有するフォトマスク（露光マスク）を介して露光し、現像し、焼成してブラックマトリクスＢＭを形成する。

【００７３】次に、感光性の赤色、緑色、青色の樹脂を使用して、上記と同様の露光、現像、焼成の工程を繰り返してカラーフィルタＦＩＬ（赤の着色層ＦＩＬ（Ｒ）、緑の着色層ＦＩＬ（Ｇ）、青の着色層ＦＩＬ（Ｂ））を順次形成する。

【００７４】このように形成したカラーフィルタＦＩＬの上層を覆って保護膜（平滑膜）ＯＣを被覆する。

【００７５】そして、ベースフィルムＢＳＦにシリカの粒子ＲＵを分散して配置した感光性の樹脂層ＰＲＳを積層してなる感光性転写シートＴＦＳを保護膜ＯＣの上に貼付する。このとき、感光性転写シートＴＦＳの感光性の樹脂層ＰＲＳが保護膜ＯＣと接合するように貼付する。

【００７６】（２）感光性の樹脂層ＰＲＳを保護膜ＯＣに貼付後、ベースフィルムＢＳＦを剥離して感光性の樹脂層ＰＲＳのみを残す。

【００７７】（３）柱状スペーサＳＰを形成する位置（ここでは、ブラックマトリクスＢＭの直上）に対応した開口パターンを有するフォトマスクＰＭＳＫを介して感光性の樹脂層ＰＲＳに紫外線を照射する。ここでは、感光性の樹脂は紫外線を照射した部分が硬化するネガ型を想定しているが、紫外線を照射した部分が現像で除去されるポジ型の感光性の樹脂を用いることもでき、その場合は、柱状スペーサＳＰを形成する位置以外の部分に対応する開口パターンを有するフォトマスクを用いる。

【００７８】（４）露光後、現像して感光性の樹脂層ＰＲＳの非露光部分を除去し、焼成することにより、シリカの粒子ＲＵが分散配置された柱状スペーサＳＰが形成される。

【００７９】なお、ここでは、図４に示した感光性転写シートを用いた例を説明したが、図５または図６に示した感光性転写シートを用いた製造方法も同様である。ただし、図５の感光性転写シートを用いる場合は、柱状スペーサＳＰの形成位置と感光性転写シートの粒子ＲＵ分散位置との位置合わせが必要である。また、図６に示した感光性転写シートを用いた場合は感光性の樹脂層ＰＲＳを保護膜ＯＣに貼付後、ベースフィルムＢＳＦを剥離する作業が容易となる。

【００８０】本実施例により、セルギャップを均一にするための柱状スペーサの機械的な強度を向上させることができ、かつこのような柱状スペーサを正確、かつ容易に形成することができる。

【００８１】図８は図４で説明した感光性転写シートを用いた柱状スペーサの形成方法を含むカラーフィルタ基板の製造方法の第２実施例を説明する概略工程図であり、図７と同様の工程（１）～（４）の順に処理される。本実施例が前記図７で説明した第１実施例とは感光性転写シートを構成するベースフィルムの取扱で異なる。すなわち、

（１）カラーフィルタ基板ＳＵＢ２は厚さが０．７ｍｍまたは１．１ｍｍのガラス基板であり、この基板ＳＵＢ２上に黒色の感光性樹脂を塗布し、ブラックマトリクスの配置パターンに対応した所定の開口パターンを有するフォトマスク（露光マスク）を介して露光し、現像し、焼成してブラックマトリクスＢＭを形成する。

【００８２】次に、感光性の赤色、緑色、青色の樹脂を使用して、上記と同様の露光、現像、焼成の工程を繰り返してカラーフィルタＦＩＬ（赤の着色層ＦＩＬ（Ｒ）、緑の着色層ＦＩＬ（Ｇ）、青の着色層ＦＩＬ（Ｂ））を順次形成する。

【００８３】このように形成したカラーフィルタＦＩＬの上層を覆って保護膜（平滑膜）ＯＣを被覆する。

【００８４】そして、ベースフィルムＢＳＦにシリカの粒子ＲＵを分散して配置した感光性の樹脂層ＰＲＳを積層してなる感光性転写シートＴＦＳを保護膜ＯＣの上に貼付する。このとき、感光性転写シートＴＦＳの感光性の樹脂層ＰＲＳが保護膜ＯＣと接合するように貼付す

る。この工程は図７の実施例と同様である。

【００８５】（２）感光性の樹脂層ＰＲＳを保護膜ＯＣに貼付後、ベースフィルムＢＳＦを剥離しないで、そのまま残しておく。

【００８６】（３）柱状スペーサＳＰを形成する位置（ここでは、ブラックマトリクスＢＭの直上）に対応した開口パターンを有するフォトマスクＰＭＳＫを感光性転写シートＴＦＳのベースフィルムＢＳＦに積層し、このフォトマスクＰＭＳＫを介して感光性の樹脂層ＰＲＳに紫外線を照射する。なお、ここでは、感光性の樹脂は紫外線を照射した部分が硬化するネガ型を想定しているが、紫外線を照射した部分が現像で除去されるポジ型の感光性の樹脂を用いることもできることは前記したとおりである。

【００８７】図７で説明した実施例では、フォトマスクＰＭＳＫを何らかの手段を用いて感光性樹脂層ＰＲＳに対して所定の間隔で保持する必要があるが、本実施例ではベースフィルムＢＳＦに直接フォトマスクＰＭＳＫを積層する方法を採用したことにより、ベースフィルムＢＳＦの厚さを変えることでフォトマスクＰＭＳＫと感光性樹脂層ＰＲＳの間隔を正確に設定することが可能となる。

【００８８】（４）露光後、ベースフィルムＢＳＦを剥離し、感光性の樹脂層ＰＲＳの非露光部分を現像により除去し、焼成することにより、シリカの粒子ＲＵが分散配置された柱状スペーサＳＰが形成される。

【００８９】なお、図５または図６に示した感光性転写シートを用いた場合も同様の工程で柱状スペーサＳＰを形成できる。

【００９０】本実施例によっても、セルギャップを均一にするための柱状スペーサの機械的な強度を向上させることができ、かつ、このような柱状スペーサを正確、かつ容易に形成することができる。

【００９１】図９は図４で説明した熱転写シートを用いた柱状スペーサの形成方法を含むカラーフィルタ基板の製造方法の第３実施例を説明する概略工程図である。本実施例では、カラーフィルタ基板ＳＵＢ２にブラックマトリクスＢＭ、３色のカラーフィルタＦＩＬ（ＦＩＬ（Ｒ）、ＦＩＬ（Ｇ）、ＦＩＬ（Ｂ））、およびオーバコート層ＯＣを形成する工程までは前記各実施例と同様であるため、図示および説明は省略する。

【００９２】図９の工程（１）では、上記のようにしてカラーフィルタ等を形成したカラーフィルタ基板ＳＵＢ２のオーバコート層ＯＣに熱転写シートＴＴＦＳを貼付する。この熱転写シートＴＴＦＳは、シリカの粒子ＲＵを分散させた熱溶着性の樹脂ＴＲＳをベースフィルムＢＳＦに積層してなり、この熱溶着性の樹脂ＴＲＳ側をオーバコート層ＯＣに対向させて載置する。

【００９３】そして、ベースフィルムＢＳＦ側からサーマルヘッドＴＨを柱状スペーサを形成する位置に当てて加熱する。また、本実施例では、カラーフィルタ基板ＳＵＢ２を固定してサーマルヘッドＴＨを図中の矢印に示したように移動させて柱状スペーサを形成する位置を順次加熱する方法を採っているが、サーマルヘッドＴＨを固定し、熱転写シートＴＴＦＳおよびカラーフィルタ基板ＳＵＢ２を移動させるようにしてもよい。この場合、熱転写シートＴＴＦＳの送り量を調整することで、図９の（２）に示したような熱溶着性の樹脂ＴＲＳの残りを発生させないようにすることができ、熱転写シートＴＴＦＳの材料コストを低減する上で好ましい。

【００９４】なお、この加熱はサーマルヘッドに限るものではなく、レーザ光等の加熱用放射線を所定箇所に照射する方法を採用してもよい。

【００９５】この工程で、熱転写シートＴＴＦＳの柱状スペーサ形成位置にある熱溶着樹脂ＴＲＳがオーバコートＯＣに融着する。

【００９６】柱状スペーサ形成位置にある熱溶着性の樹脂ＴＲＳをオーバコートＯＣに融着させた後、（２）カラーフィルタ基板ＳＵＢ２から熱転写シートＴＴＦＳを引き剥がすことで柱状スペーサＳＰが形成される。

【００９７】この実施例によれば、前記図７あるいは図８で説明した方法のようなフォトリソ工程を必要としないため、柱状スペーサＳＰの形成工程が単純化される。

【００９８】また、図９の実施例では、転写シートとして図４に示した熱転写シートを使用したが、図５や図６に示した熱転写シートも上記と同様に使用できる。

【００９９】一方、アクティブマトリクス基板ＳＵＢ１は、既知の薄膜トランジスタの形成プロセスと同様のプロセスで製造できる。このアクティブマトリクス基板ＳＵＢ１として厚さ０．７ｍｍあるいは１．１ｍｍのガラス基板を用い、この基板上に成膜とパターニングを繰り返してアモルファスシリコンＡＳからなる薄膜トランジスタＴＦＴ、蓄積容量Ｃｓｔｇと画素電極ＰＸ、ソース電極ＳＤ１および対抗電極ＣＴの電極群を形成し、薄膜トランジスタＴＦＴを介して前記した電極群に所定の電圧を印加する複数の映像信号線ＤＬ、ドレイン電極ＳＤ２、対向電圧信号線ＣＬおよび薄膜トランジスタＴＦＴの導通を制御する複数の走査信号線ＧＬとゲート電極ＧＴを格子状に形成する。

【０１００】薄膜トランジスタＴＦＴ、各電極群および各配線は絶縁膜ＧＩと保護膜ＰＳＶで被覆する。その後、配向膜材料を塗布し焼成し、ラビング処理あるいは光配向処理により液晶配向制御能を付与して配向制御層ＯＲＩ１を形成する。

【０１０１】上記のようにして製作したアクティブマトリクス基板ＳＵＢ１と前記実施例で製作したカラーフィルタ基板ＳＵＢ２を対向させ、その周辺部を液晶封入口を残して接着剤で固定し、二枚の基板間に液晶組成物を封入し、液晶封入口を封止剤で封止する。

【０１０２】その後、プレスにより二枚の基板の間隔を

柱状スペーサで規制して所定のセルギャップを持つ液晶表示装置を得る。

【０１０３】次に、本発明を適用した液晶表示装置の駆動手段および具体的な製品例について説明する。

【０１０４】図１０は本発明を適用する液晶表示装置の駆動手段の概要説明図であって、液晶表示装置は画像表示部がマトリクス状に配置された複数の画素の集合により構成され、各画素は前記液晶表示装置の背部に配置された図示しないバックライトからの透過光を独自に変調制御できるように構成されている。

【０１０５】液晶表示基板の構成要素の１つであるアクティブマトリクス基板（ＳＵＢ１）上には、有効画素領域ＡＲにｘ方向（行方向）に延在し、ｙ方向（列方向）に並設された走査信号線ＧＬと対向電圧信号線ＣＬとそれぞれ絶縁されてｙ方向に延在し、ｘ方向に並設された映像信号線ＤＬが形成されている。

【０１０６】ここで、走査信号線ＧＬ、対向電圧信号線ＣＬ、映像信号線ＤＬのそれぞれによって囲まれる矩形状の領域に単位画素が形成される。

【０１０７】液晶表示装置には、その外部回路として垂直走査回路Ｖ及び映像信号駆動回路Ｈが備えられ、前記垂直走査回路Ｖによって前記走査信号線ＧＬのそれぞれに順次走査信号（電圧）が供給され、そのタイミングに合わせて映像信号駆動回路Ｈから映像信号線ＤＬに映像信号（電圧）を供給するようになっている。

【０１０８】尚、垂直走査回路Ｖ及び映像信号駆動回路Ｈは、液晶駆動電源回路３から電源が供給されるとともに、ＣＰＵ1からの画像情報がコントローラ２によってそれぞれ表示データ及び制御信号に分けられて入力されるようになっている。

【０１０９】図１１は本発明を適用する液晶表示装置の駆動波形の一例の説明図である。同図では、対向電圧をＶＣＨとＶＣＬの２値の交流矩形波にし、それに同期させて走査信号ＶＧ（ｉ－１）、ＶＧ（ｉ）の非選択電圧を１走査期間毎に、ＶＣＨとＶＣＬの２値で変化させる。対向電圧の振幅幅と非選択電圧の振幅値は同一にする。

【０１１０】映像信号電圧は、液晶層に印加したい電圧から対向電圧の振幅の１／２を差し引いた電圧である。

【０１１１】対向電圧は直流でも良いが、交流化することで映像信号電圧の最大振幅を低減でき、映像信号駆動回路（信号側ドライバ）に耐圧の低いものを用いることが可能になる。

【０１１２】図１２は本発明による液晶表示装置の全体構成を説明する展開斜視図であり、液晶表示装置（以下、２枚の基板ＳＵＢ１，ＳＵＢ２を貼り合わせてなる液晶パネル、駆動手段、バックライト、その他の構成部材を一体化した液晶表示モジュール：ＭＤＬと称する）の具体的構造を説明するものである。

【０１１３】ＳＨＤは金属板からなるシールドケース（メタルフレームとも言う）、ＷＤは表示窓、ＩＮＳ１～３は絶縁シート、ＰＣＢ１～３は駆動手段を構成する回路基板（ＰＣＢ１はドレイン側回路基板：映像信号線駆動用回路基板、ＰＣＢ２はゲート側回路基板、ＰＣＢ３はインターフェース回路基板）、ＪＮ１～３は回路基板ＰＣＢ１～３同士を電気的に接続するジョイナ、ＴＣＰ１，ＴＣＰ２はテープキャリアパッケージ、ＰＮＬは液晶パネル、ＧＣはゴムクッション、ＩＬＳは遮光スペーサ、ＰＲＳはプリズムシート、ＳＰＳは拡散シート、ＧＬＢは導光板、ＲＦＳは反射シート、ＭＣＡは一体化成形により形成された下側ケース（モールドフレーム）、ＭＯはＭＣＡの開口、ＬＰは蛍光管、ＬＰＣはランプケーブル、ＧＢは蛍光管ＬＰを支持するゴムブッシュ、ＢＡＴは両面粘着テープ、ＢＬは蛍光管や導光板等からなるバックライトを示し、図示の配置関係で拡散板部材を積み重ねて液晶表示モジュールＭＤＬが組立てられる。

【０１１４】液晶表示モジュールＭＤＬは、下側ケースＭＣＡとシールドケースＳＨＤの２種の収納・保持部材を有し、絶縁シートＩＮＳ１～３、回路基板ＰＣＢ１～３、液晶パネルＰＮＬを収納固定した金属製のシールドケースＳＨＤと、蛍光管ＬＰ、導光板ＧＬＢ、プリズムシートＰＲＳ等からなるバックライトＢＬを収納した下側ケースＭＣＡとを合体させてなる。

【０１１５】映像信号線駆動用回路基板ＰＣＢ１には液晶パネルＰＮＬの各画素を駆動するための集積回路チップが搭載され、またインターフェース回路基板ＰＣＢ３には外部ホストからの映像信号の受入れ、タイミング信号等の制御信号を受け入れる集積回路チップ、およびタイミングを加工してクロック信号を生成するタイミングコンバータＴＣＯＮ等が搭載される。

【０１１６】上記タイミングコンバータで生成されたクロック信号はインターフェース回路基板ＰＣＢ３および映像信号線駆動用回路基板ＰＣＢ１に敷設されたクロック信号ラインＣＬＬを介して映像信号線駆動用回路基板ＰＣＢ１に搭載された集積回路チップに供給される。

【０１１７】インターフェース回路基板ＰＣＢ３および映像信号線駆動用回路基板ＰＣＢ１は多層配線基板であり、上記クロック信号ラインＣＬＬはインターフェース回路基板ＰＣＢ３および映像信号線駆動用回路基板ＰＣＢ１の内層配線として形成される。

【０１１８】なお、液晶パネルＰＮＬにはＴＦＴを駆動するためのドレイン側回路基板ＰＣＢ１、ゲート側回路基板ＰＣＢ２およびインターフェース回路基板ＰＣＢ３がテープキャリアパッケージＴＣＰ１，ＴＣＰ２で接続され、各回路基板間はジョイナＪＮ１，２，３で接続されている。

【０１１９】液晶パネルＰＮＬは前記した本発明による横電界方式のアクティブマトリクス型液晶表示装置であり、その２枚の基板の間隔を所定値に維持するために前

記実施例で説明した粒子入りの柱状スペーサを備えている。

【０１２０】図１３は本発明による液晶表示装置を実装した電子機器の一例としてのノート型コンピュータの斜視図である。

【０１２１】このノート型コンピュータ（可搬型パソコン）はキーボード部（本体部）と、このキーボード部にヒンジで連結した表示部から構成される。キーボード部にはキーボードとホスト（ホストコンピュータ）、ＣＰＵ等の信号生成機能を収納し、表示部には液晶パネルＰＮＬを有し、その周辺に駆動回路基板ＰＣＢ１，ＰＣＢ２、コントロールチップＴＣＯＮを搭載したＰＣＢ３、およびバックライト電源であるインバータ電源基板などが実装される。

【０１２２】そして、上記液晶表示パネルＰＮＬ、各種回路基板ＰＣＢ１，ＰＣＢ２，ＰＣＢ３、インバータ電源基板、およびバックライトを一体化した図１２で説明した液晶表示モジュールを実装してある。

【０１２３】なお、上記実施例は、所謂横電界型の液晶表示装置に本発明を適用した構成について説明したが、本発明はこれに限るものではなく、スペーサに粒子を混入した点でセルギャップを均一に保つ必要のある他の液晶表示装置にも同様に適用できることは言うまでもない。

【０１２４】

【発明の効果】以上説明したように、本発明によれば、映像信号線と対向電極の間、または映像信号線と画素電極の領域を覆うように配置した柱状スペーサ及びその内部にセルギャップとほぼ同じ大きさの粒子によって、表示画面内のセルギャップが均一に形成され、表示画面内の輝度が均一となる。

【０１２５】また、上記各電極間の領域における液晶が部分的に排除されるため、上記電極間の領域の透過光は、これら電極間に形成される電界に影響されにくい。

【０１２６】従って、当該領域の光漏れ量は少なくなり、コントラストや輝度が向上し、クロストークの発生が防止され、高品質の画像表示の液晶表示装置が得られる。

【図面の簡単な説明】

【図１】本発明に係る液晶表示装置の第１実施例である横電界方式アクティブマトリクス型液晶表示装置を構成する液晶パネルの画素付近の構成を模式的に説明する要部平面図である。

【図２】図１の１－１’線に沿った要部断面図である。

【図３】本発明に係る液晶表示装置の第２実施例である横電界方式アクティブマトリクス型液晶表示装置を構成する液晶パネルの画素付近の構成を模式的に説明する要部平面図である。

【図４】本発明による液晶表示装置の製造方法を説明する柱状スペーサ形成用の転写シートの第１例を説明する模式断面図である。

【図５】本発明による液晶表示装置の製造方法を説明する柱状スペーサ形成用の転写シートの第２例を説明する模式断面図である。

【図６】本発明による液晶表示装置の製造方法を説明する柱状スペーサ形成用の転写シートの第３例を説明する模式断面図である。

【図７】図４で説明した感光性転写シートを用いた柱状スペーサの形成方法を含むカラーフィルタ基板の製造方法の第１実施例を説明する概略工程図である。

【図８】図４で説明した感光性転写シートを用いた柱状スペーサの形成方法を含むカラーフィルタ基板の製造方法の第２実施例を説明する概略工程図である。

【図９】図４で説明した熱転写シートを用いた柱状スペーサの形成方法を含むカラーフィルタ基板の製造方法の第３実施例を説明する概略工程図である。

【図１０】本発明を適用する液晶表示装置の駆動手段の概要説明図である。

【図１１】本発明を適用する液晶表示装置の駆動波形の一例の説明図である。

【図１２】本発明による液晶表示装置の全体構成を説明する展開斜視図である。

【図１３】本発明による液晶表示装置を実装した電子機器の一例としてのノート型コンピュータの斜視図である。

【図１４】横電界方式の液晶表示装置で形成される電界を説明する要部断面図である。

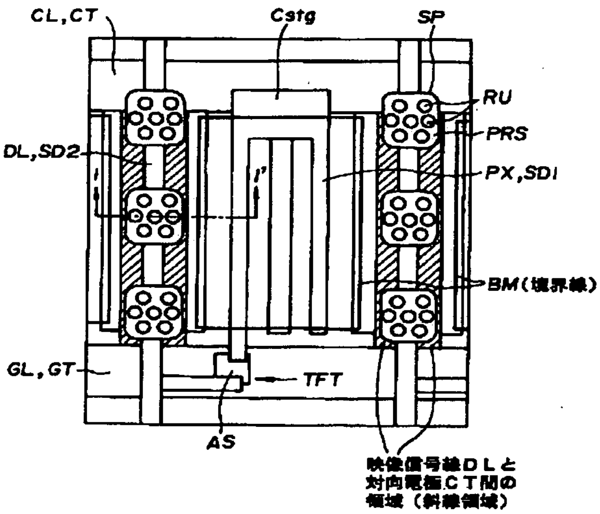
【符号の説明】

ＤＬ　映像信号線
ＳＤ２　映像信号線から延びるドレイン電極
ＣＬ　対向電圧信号線
ＣＴ　対向電圧信号線と同一の対向電極
ＰＸ　画素電極
ＳＤ１　画素電極と同一のソース電極
Ｃｓｔｇ　蓄積容量
ＧＬ　走査信号線
ＧＴ　走査電極と同一のゲート電極
ＢＭ　ブラックマトリクス（画素部開口の境界線で示す）
ＴＦＴ　薄膜トランジスタ
ＳＰ　柱状スペーサ。
ＲＵ　粒子
ＯＲＩ　配向膜
ＯＣ　オーバーコート層
ＦＩＬ　カラーフィルタ
ＡＯＦ　絶縁膜
ＬＣ　液晶層
ＧＩ　ゲート絶縁膜
ＰＳＶ　パッシベーション層（保護膜）
ＰＯＬ　偏光板

ＳＵＢ　基板。

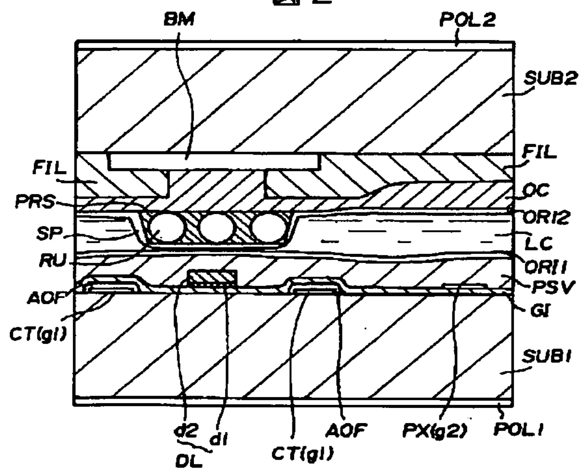
【図１】

図１



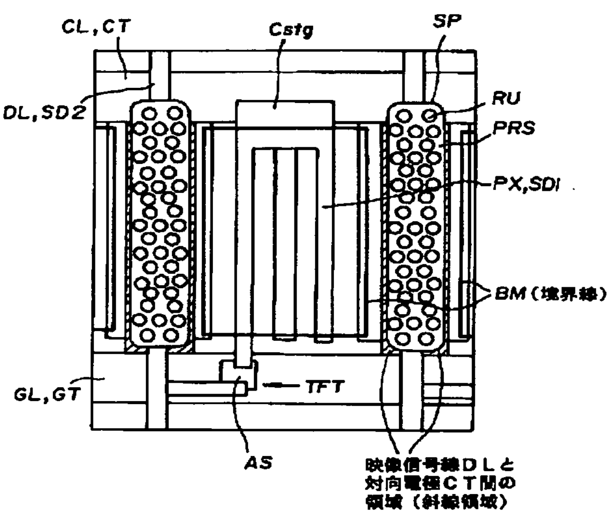
【図２】

図２



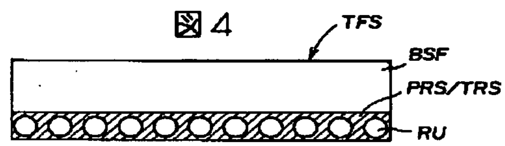
【図３】

図３



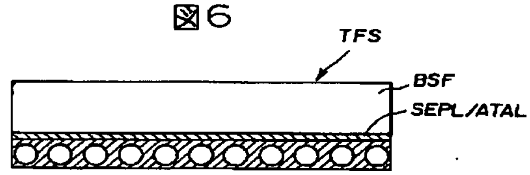
【図４】

図４



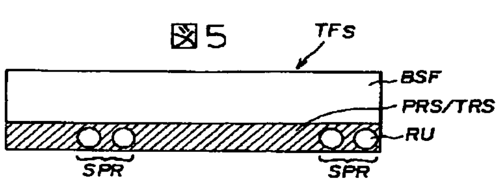
【図６】

図６



【図５】

図５



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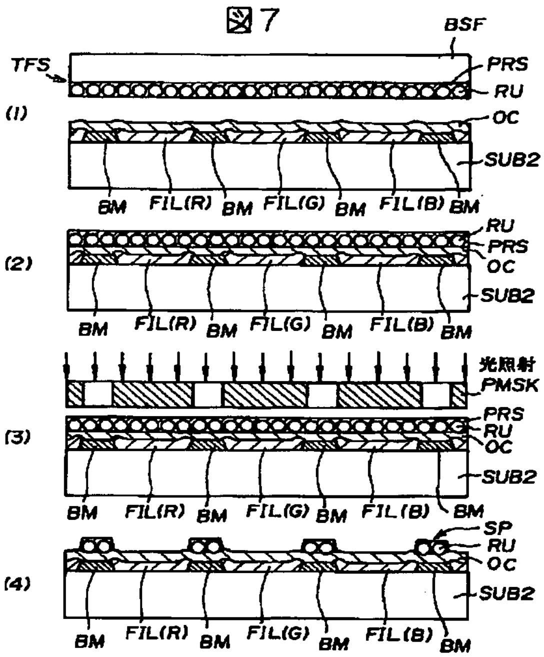

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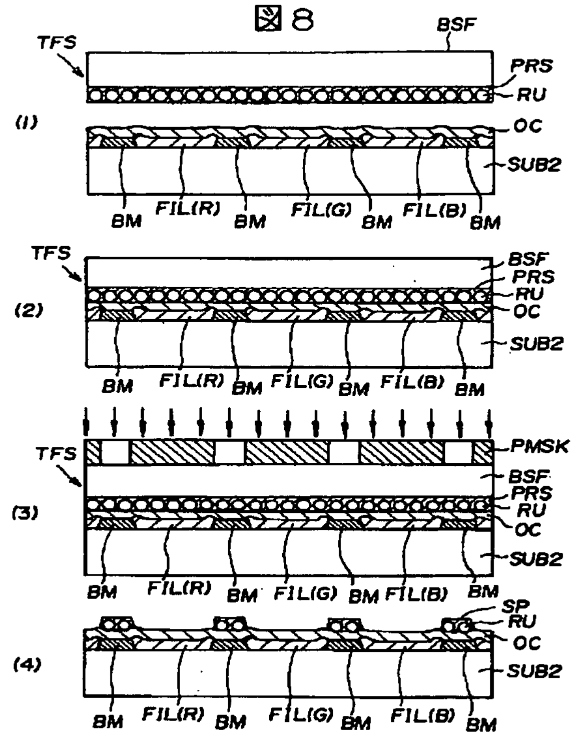

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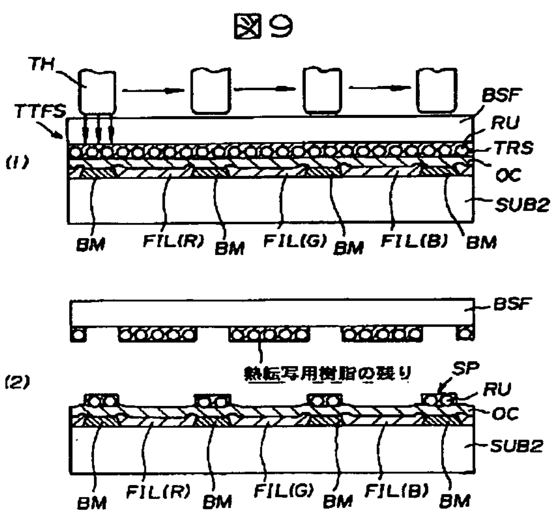

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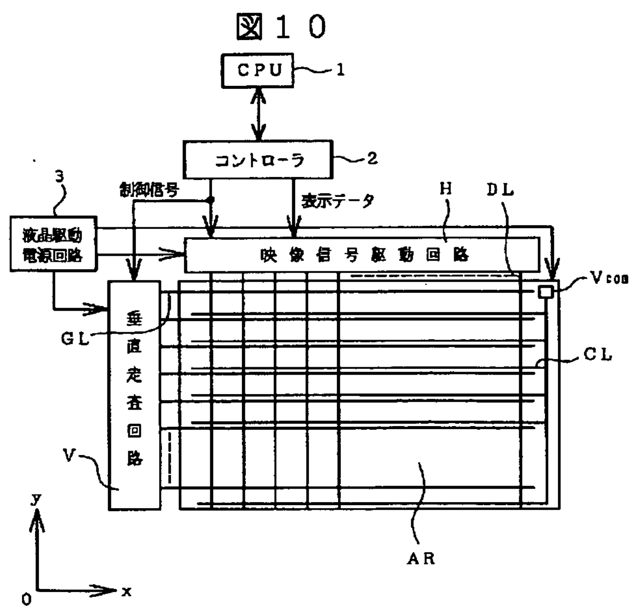

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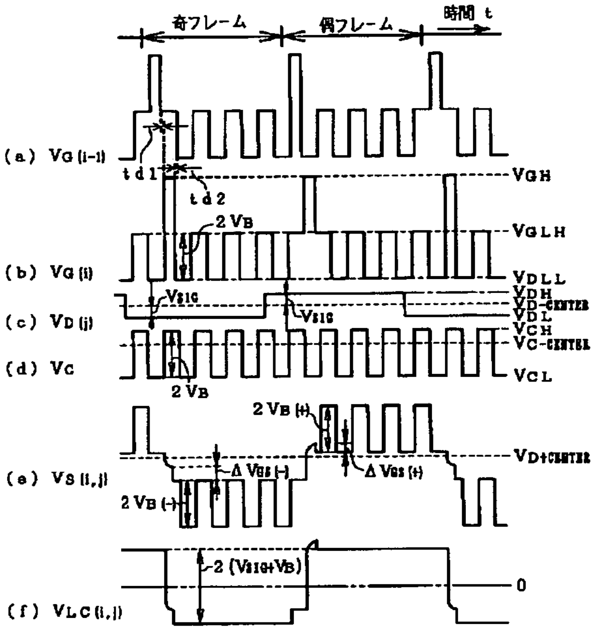
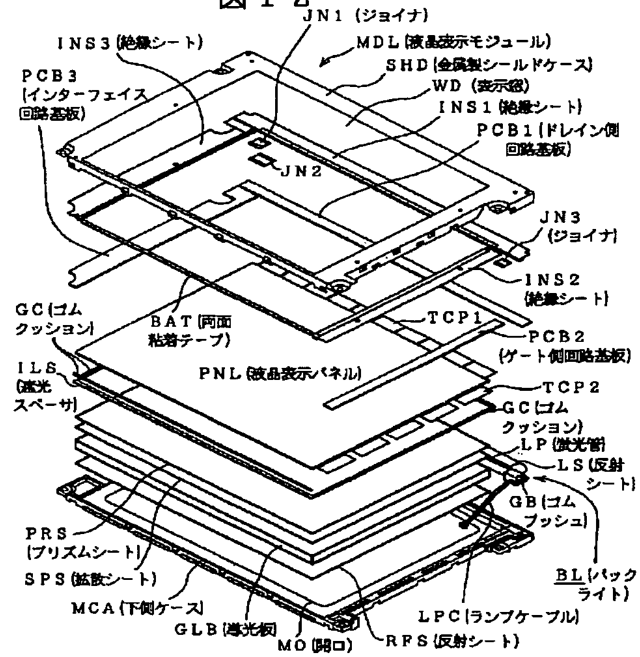
【図１１】

図１１



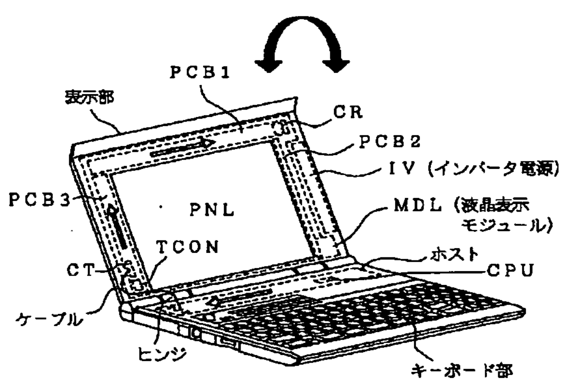
【図１２】

図１２



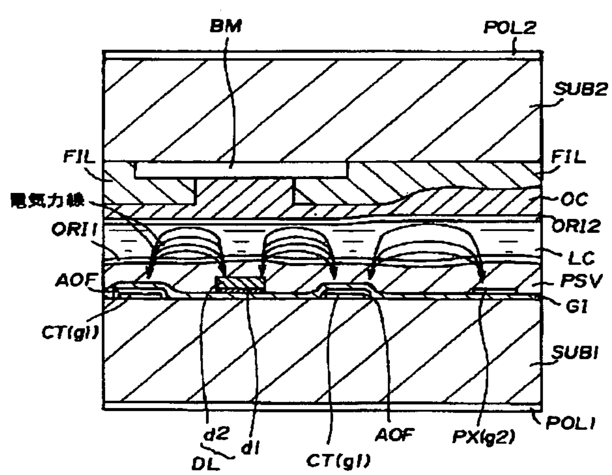
【図１３】

図１３



【図１４】

図１４



フロントページの続き

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TA12 TA13　05
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FB04 FC12 FD04 GA13 LA03
LA15 LA18

Translation of JP 2000-275654A

LIQUID CRYSTAL DISPLAY DEVICE AND FABRICATION METHOD THEREOF

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a liquid crystal display device and, more particularly, to a liquid crystal display device provided with a spacer having a novel construction for keeping the distance between a pair of substrates which seal liquid crystal compounds constituting a liquid crystal layer uniformly, as well as to a method of fabricating such a liquid crystal display device.

2. Description of the Related Art

Liquid crystal display devices are widely used as display devices which are able to provide high-resolution and color display for notebook type computers or computer monitors.

These kinds of liquid crystal display devices basically includes a so-called liquid crystal panel in which liquid crystal compounds are interposed between at least two opposed substrates at least one of which is made of transparent glass, plastics or the like, and are generally divided into a simple matrix type which selectively applies voltages to various kinds of pixel-forming electrodes formed over the substrates of the liquid crystal panel and turns on and off predetermined pixels, and an active matrix type in which the various kinds of electrodes and pixel-selecting active elements are formed to turn on and off predetermined pixels by making selection from these active elements.

The active matrix type liquid crystal display devices are represented by a type which uses thin film transistors (TFTs) as active elements. Liquid crystal display devices using thin film transistors have been widely spread as monitors for display terminals of OA equipment because of their thin sizes and light weights as well as their

high image qualities which compare with Braun tubes.

The display methods of such a liquid crystal display device are generally divided into the following two methods according to the difference between their liquid crystal driving methods. One of the methods is to interpose liquid crystal compounds between two substrates on both of which transparent electrodes are formed, operate the liquid crystal compounds by applying voltages to the respective transparent electrodes, and modulate light passing through the transparent electrodes and entering the layer of the liquid crystal compounds for displaying an image, thereby. This method is adopted to almost all currently popular products.

The other method is to operate a liquid crystal by an electric field which is generated between two electrodes formed on the same substrate, nearly in parallel with the surface thereof, and modulate light entering the layer of liquid crystal compounds through the gap between the two electrodes, for displaying an image thereby. This method is also called a lateral electric field type method or an IPS (In-Plane-Switching) method, and active matrix liquid crystal display devices adopting this method have the feature of remarkably wide viewing angles. The feature of this method is described in, for example, International Patent Publication No. 505247/1993, Japanese Patent Publication No. 21907/1988 and Japanese Patent Laid-Open No. 160878/1994. This type of liquid crystal display device will be hereinafter referred to as the lateral electric field type of liquid crystal display device.

Fig. 14 is a cross-sectional view of the essential portion of the lateral electric field type of liquid crystal display device, and illustrates an electric field to be formed in the same. This liquid crystal display device has video signal lines DL, counter electrodes CT and pixel electrodes PX all of which are formed on a substrate SUB1, as well as an orientation control layer ORI1 formed at the interface between a protective

layer PSV and a layer LC of liquid crystal compounds both of which are formed over these portions DL, CT and PX. The liquid crystal display device also has color filters FIL partitioned by a black matrix BM, an overcoat layer OC being deposited to prevent the constituent materials of the color filter or the black matrix from affecting the liquid crystal compounds (hereinafter called the liquid crystal, also) constituting the liquid crystal layer LC, and an orientation control layer ORI2 formed at the interface between the overcoat layer OC and the layer of the liquid crystal LC, each of which is formed over the other substrate SUB2.

Insulating layers GI and AOF are formed over the substrate SUB1. The video signal lines DL are made of two conductive layers d1 and d2, the counter electrodes CT are made of a conductive layer g1, and the pixel electrodes PX are made of a conductive layer g2.

Furthermore, the distance between the pair of substrates SUB1 and SUB2 (the thickness of the layer of the liquid crystal compounds or the gap between the substrates SUB1 and SUB2: a cell gap) is generally set to a predetermined value by dispersing spherical spacers (not shown) between both substrates. Polarizers POL1 and POL2 are respectively disposed on the external surfaces of the substrates SUB1 and SUB2.

In addition, although not associated with the lateral electric field type of liquid crystal display device, Japanese Patent Laid-Open No. 73088/1997 discloses the art of forming conical spacers on a protective film of a color filter substrate in such a manner as to be fixed to the substrate or stacking color filter layers to form cylindrical spacers fixedly, instead of forming such spherical spacers.

In the invention disclosed in Japanese Patent Laid-Open No. 73088/1997, in the case of the spherical spacers, the spacers are formed to be fixed to the substrate in order to solve the problem that contrast is lowered by light leaks from portions

surrounding the spacers, or that the spacers are so non-uniformly dispersed in the step of dispersing the spacers over the substrate as to cause a display defect.

Another method of forming spacers which keep the gap between substrates is disclosed in Japanese Patent Laid-Open No. 325298/1995. This method uses a step of stacking a photosensitive sheet having a base film coated with a photosensitive resin on a substrate and a photolithographic process including an exposure step using a mask and a development step. This method aims to uniformalize the film thickness of the spacers and prevent color irregularity.

SUMMARY OF THE INVENTION

There are two problems to be solved by the present invention. One of the problems relates to a liquid crystal display device in which spacers are formed to be fixed to a substrate. The spacers fixed in this manner will be hereinafter referred to as the columnar spacers.

Since the spacers are formed for the purpose of uniformalizing a cell gap, the film thickness of the columnar spacers needs to be uniformalized. For this reason, for example, in the aforementioned Japanese Patent Laid-Open No. 325298/1995, a photosensitive sheet having a photosensitive resin of uniform film thickness formed over a base film in advance is stacked on the substrate, and the columnar spacers are formed through a photolithographic process.

This method is considered to be superior in terms of the uniformity of film thickness compared to a method of coating a substrate with a photosensitive resin, for example, a spin coating method. However, in the photolithographic process after the stacking of the photosensitive sheet, non-uniformity occurs in the film thickness of the columnar spacers within each substrate surface or among individual substrates owing to

the uniformity of in-plane distribution of the irradiation intensity of exposure light, in-plane non-uniformity in a development step, or the like. As a result, brightness irregularity due to the non-uniformity of the cell gap occurs..

In the fabrication of a liquid crystal display device, the mechanical characteristics of spacers are important. The substrate surfaces of the liquid crystal display device are not flat and have small steps (1 μm or less). Even if the film thickness of the spacers is uniform, certain portions of the substrate surface on which the spacers are disposed have possibility of constituting non-uniform steps. Therefore, for making the cell gap uniformly, it is necessary to squeeze the spacers between the substrates or to press the spacers into constituent layers on the substrates. Accordingly, the columnar spacers are also required to have characteristics such as elasticity and hardness equivalent to those of spherical spacers. However, it is difficult to require the columnar spacers made of an organic material such as a photosensitive resin to have mechanical characteristic equivalent to that of spherical spacers made of an inorganic material such as glass or silica or that of spherical spacers formed of a plastic material.

The second problem to be solved by the present invention is subject matter associated with pixel design in the lateral electric field type of liquid crystal display device. If the distance between electrodes is made as large, or the optical density of the black matrix BM is made as high as the conventionally used technique, the following problems occur.

If the distance between the video signal line DL and the counter electrode CT or the distance between the video signal line DL and the pixel electrode PX is so increased as to decrease the electric field strength therebetween, a display pixel area is forced to be so reduced as to incur a decrease in brightness thereof due to a decrease in the aperture ratio thereof or an increase in power consumption thereby.

On the other hand, if the optical density of the black matrix BM is to be increased, the following problems occur. In the lateral electric field type of liquid crystal display device, the black matrix BM needs to have high resistance (for example, Japanese Patent Laid-Open No. 43589/1997). The electrical characteristics of the black matrix BM affect the formation of a lateral electric field approximately parallel to the substrate, and if the resistance of the black matrix BM is low, an ideal lateral electric field is not formed, so that there occur problems such as a decrease in brightness, a decrease in contrast and a reduction in viewing angle.

To give the black matrix BM high resistance, it is preferable to use a pigment dispersion type photosensitive resin. At this time, if the pigment density ratio in the photosensitive resin is increased so that the optical density of the black matrix BM is increased, the resin density decreases and the processing precision of a photolithographic process is degraded. Specifically, there occur problems such as a decrease in resolution (during the exposure step), a decrease in development margin and the occurrence of pigment residues.

If the film thickness of the black matrix BM is increased so that the optical density is increased, the flatness of a color filter is degraded and a deterioration occurs in the rubbing characteristics of an orientation control layer ORI2 and the cell gap become difficult to uniformalize, leading to a defective display quality such as a degradation in response speed.

The present invention aims to solve the above-described two problems, and a first object of the present invention is to uniformalize the brightness of its display screen of the liquid crystal display device, or to provide a liquid crystal display device being free of decreases in both contrast and brightness as well as occurrence of crosstalk therein without decreasing aperture ratio thereof even if a black matrix of comparatively

low optical density is used therein.

A second object of the present invention is to provide a method of fabricating the above-described liquid crystal display device.

To achieve the first object, the present invention is characterized by being provided with columnar spacers each of which contains at a uniform density grains of size approximately equal to the thickness of a liquid crystal layer formed between a pair of substrates which constitute a liquid crystal panel.

Typical constructions for achieving the first object of the present invention are as described below in (1) to (3).

(1) A liquid crystal display device includes: a liquid crystal panel having a pair of substrates at least one of which is transparent, at least two or more kinds of color filters of different colors for displaying a color display, which are formed over one of the pair of substrates, a black matrix inserted between each of the color filters, electrode groups formed over the pair of substrates, a liquid crystal layer having dielectric anisotropy between the pair of substrates, and an orientation control layer for aligning a molecular orientation of liquid crystal compounds constituting this liquid crystal layer in a predetermined direction; and driving means for applying driving voltages to the electrode groups. In the liquid crystal display device, at least one of the pair of substrates has columnar spacers made of a resin in which grains each having a size approximately equal to a desired thickness of the liquid crystal layer is approximately uniformly dispersed.

According to this construction, it is possible to obtain a liquid crystal display device in which the brightness of its display screen is uniformalized and decreases in contrast and brightness as well as crosstalk are prevented.

(2) In the above construction (1), a diameter of each of the grains contained in the

columnar spacers is smaller than the thickness of a liquid crystal layer in a central portion of a pixel formed in the black matrix of the liquid crystal panel.

According to this construction, it is possible to obtain a liquid crystal display device which is uniformalized in the brightness of its display screen and is not decreased in aperture ratio and in which decreases in contrast and brightness as well as crosstalk are prevented.

(3) In the above construction (1) or (2), a dielectric constant or an electric conductivity of each of the columnar spacers is higher than that of liquid crystal compounds which constitute the liquid crystal layer, and each of the columnar spacers is formed in a portion between the signal line and a common line which are disposed at a position hidden by the black matrix.

According to this construction, it is possible to obtain a liquid crystal display device which is uniformalized in the brightness of its display screen and is not decreased in aperture ratio and in which even if a black matrix of comparatively low optical density is used, decreases in contrast and brightness as well as the occurrence of crosstalk are prevented.

To achieve the second object, the present invention is characterized by forming columnar spacers each of which contains at a uniform density grains of size approximately equal to the thickness of a liquid crystal layer formed between a pair of substrates which constitute a liquid crystal panel.

Typical methods of fabricating a liquid crystal display device for achieving the second object of the present invention are as described below in (4) and (5).

(4) A method of fabricating a liquid crystal display device includes: a liquid crystal panel having a pair of substrates at least one of which is transparent, at least two or more kinds of color filters of different colors for displaying a color display, which are

formed over one of the pair of substrates, a black matrix inserted between each of the color filters, electrode groups including signal lines and common lines all of which are formed over the other of the pair of substrates, a liquid crystal layer having dielectric anisotropy between the pair of substrates opposed to each other with a predetermined gap interposed therebetween, an orientation control layer for aligning a molecular orientation of the liquid crystal layer in a predetermined direction, and columnar spacers made of a resin in which grains each having a size approximately equal to a desired thickness of the liquid crystal layer is dispersed at a uniform density, the columnar spacers being formed over at least one of the pair of substrates: polarizers stacked on the respective substrates with their polarizing axes intersecting with each other; and driving means for applying driving voltages to the electrode groups. The method includes: sticking a photosensitive transfer sheet having a photosensitive resin layer stacked over a surface of a base film to one substrate which constitutes the pair of substrates, with the photosensitive resin layer being opposed to the one substrate, the photosensitive resin layer containing grains having a grain size approximately equal to the predetermined gap; and exposing and developing the photosensitive resin layer via a mask having an aperture pattern corresponding to positions at which to form the columnar spacers, and removing an unexposed portion of the photosensitive resin layer with an exposed portion being left, thereby forming the columnar spacers each made of a resin in which grains each having a size approximately equal to a thickness of the liquid crystal layer is approximately uniformly dispersed.

By using this fabrication method, it is possible to fabricate a liquid crystal display device which is uniformalized in the brightness of its display screen and is not decreased in aperture ratio and in which even if a black matrix of comparatively low optical density is used, decreases in contrast and brightness as well as the occurrence of

crosstalk are prevented..

(5) A method of fabricating a liquid crystal display device includes: a liquid crystal panel having a pair of substrates at least one of which is transparent, at least two or more kinds of color filters of different colors for displaying a color display, which are formed over one of the pair of substrates, a black matrix inserted between each of the color filters, electrode groups including signal lines and common lines all of which are formed over the other of the pair of substrates, a liquid crystal layer having dielectric anisotropy between the pair of substrates opposed to each other with a predetermined gap interposed therebetween, an orientation control layer for aligning a molecular orientation of the liquid crystal layer in a predetermined direction, and columnar spacers made of a resin in which grains each having a size approximately equal to a desired thickness of the liquid crystal layer is dispersed at a uniform density, the columnar spacers being formed over at least one of the pair of substrates: polarizers stacked on the respective substrates with their polarizing axes intersecting with each other; and driving means for applying driving voltages to the electrode groups. The method includes: sticking a thermal transfer sheet having a thermodepositable resin layer stacked over a surface of a base film to one substrate which constitutes the pair of substrates, with the thermodepositable resin layer being opposed to the one substrate, the thermodepositable resin layer containing grains having a grain size approximately equal to the predetermined gap; and selectively heating portions of the thermal transfer sheet which correspond to positions at which to form the columnar spacers, fusing only the heated portions to the one substrate, and removing unheated portions and the thermal transfer sheet, thereby forming the columnar spacers each made of a resin in which grains each having a size approximately equal to a thickness of the liquid crystal layer is approximately uniformly dispersed.

By using this fabrication method, it is possible to fabricate a liquid crystal display device which is uniformalized in the brightness of its display screen and is not decreased in aperture ratio and in which even if a black matrix of comparatively low optical density is used, decreases in contrast and brightness as well as the occurrence of crosstalk are prevented.

Furthermore, the present invention is not limited to any of the above-described constructions, and can also be applied to a so-called vertical electric field type of active matrix type liquid crystal display device or a simple matrix type of liquid crystal display device which includes a pair of substrates each having pixel selecting electrodes and forms an electric field in a direction perpendicular to the pair of substrates to control the direction of alignment of liquid crystal compounds which constitute a liquid crystal layer. The fabrication method can also be applied to various other kinds of display devices in which it is necessary to set small gaps.

Various modifications of the present invention can be made without departing from the technical ideas described in the appended claims..

These and other objects, features and advantages of the present invention will become more apparent from the following description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a plan view of a pixel and a periphery thereof being formed in a liquid crystal display panel of the lateral electric field type active matrix liquid crystal display device as a first embodiment of the liquid crystal display device according to the present invention for explaining a construction thereof schematically;

Fig. 2 is a cross sectional view being taken along a line 1-1' of Fig. 1;

Fig. 3 is a plan view of a pixel and a periphery thereof being formed in a liquid crystal display panel of the lateral electric field type active matrix liquid crystal display device as a second embodiment of the liquid crystal display device according to the present invention for explaining a construction thereof schematically;

Fig. 4 is a cross sectional view of a first example of transfer sheets for forming columnar spacers for explaining the fabrication method of the liquid crystal display device according to the present invention;

Fig. 5 is a cross sectional view of a second example of transfer sheets for forming columnar spacers for explaining the fabrication method of the liquid crystal display device according to the present invention;

Fig. 6 is a cross sectional view of a third example of transfer sheets for forming columnar spacers for explaining the fabrication method of the liquid crystal display device according to the present invention;

Figs. 7A through 7D are schematic process diagrams for explaining a first embodiment of the fabrication method of the color filter substrate according to the present invention including the forming method of the columnar spacers using the photosensitive transfer sheet being explained with reference to Fig. 4;

Figs. 8A through 8D are schematic process diagrams for explaining a second embodiment of the fabrication method of the color filter substrate according to the present invention including the forming method of the columnar spacers using the photosensitive transfer sheet being explained with reference to Fig. 4;

Figs. 9A and 9B are schematic process diagrams for explaining a third embodiment of the fabrication method of the color filter substrate according to the present invention including the forming method of the columnar spacers using the thermal transfer sheet being explained with reference to Fig. 4;

Fig. 10 is an explanatory diagram showing driving means for the liquid crystal display device to which the present invention is applied;

Fig. 11 is an explanatory diagram of one instance of driving waveforms of the liquid crystal display device to which the present invention is applied;

Fig. 12 is a disassembled squint view of a liquid crystal display device for explaining a whole construction of the liquid crystal display devices according to the present invention;

Fig. 13 is a squint view of a notebook type computer as one instance of electronic equipment in which a liquid crystal display device according to the present invention is mounted; and

Fig. 14 is a cross sectional view of a lateral electric field type liquid crystal display device for explaining an electric field being generated therein.

DETAILED DESCRIPTION

Embodiments of the present invention will be explained below in detail hereinafter with reference to the drawings related thereto.

Fig. 1 is a plan view schematically illustrating the construction of the essential portion of the vicinity of the pixel of a liquid crystal display panel constituting a lateral electric field type active matrix liquid crystal display device as a first embodiment of the liquid crystal display device according to the present invention. Fig. 2 is a cross-sectional view of the essential portion taken along line 1-1' of Fig. 1.

Incidentally, in Figs. 1 and 2, reference signs identical to those shown in Fig. 14 correspond to identical functional portions, and various kinds of electrodes and structure layers all of which are disposed between a pair of substrates SUB1 and SUB2 are similar to those shown in Fig. 14 except for columnar spacers SP and grains RU

contained therein..

In Fig. 1, symbol DL denotes a video signal line, symbol SD2 a drain electrode extending from the video signal line, symbol CL a counter voltage signal line, symbol CT a counter electrode identical to the counter voltage signal line, symbol PX a pixel electrode, symbol SD1 a source electrode identical to the pixel electrode, symbol Cstg a storage capacitance, symbol GL a scanning signal line, symbol GT a gate electrode identical to the scanning electrode, symbol BM a black matrix (shown by the boundary of the aperture thereof corresponding to the pixel), symbol TFT a thin film transistor, symbol SP a columnar spacer, symbol PRS a resin, and symbol RU a grain. Incidentally, each hatched portion shown in Fig. 1 represents the area between the video signal line DL and the counter electrode CT.

In Fig. 2, symbol SUB1 denotes one of the substrates (an active matrix substrate or a TFT substrate), symbol SUB2 the other of the substrates (a color filter substrate), symbol GI a gate insulating layer, symbol PSV a passivation layer (a protective layer), symbol ORI1 an alignment layer (an orientation control layer) formed over the substrate SUB1, symbol LC a liquid crystal, symbol ORI2 an alignment layer (an orientation control layer) formed over the substrate SUB2, symbol OC an overcoat layer (a leveling layer), symbol FIL a color filter, and symbol BM a black matrix. As apparent from Figs. 1 and 2, each pixel of the lateral electric field type liquid crystal display device to be referred in the present embodiment has a feature in that the position of the pixel electrode PX which generates an electric field to drive the liquid crystal LC (an electrode having a first potential) and the position of the counter electrode CT (an electrode having a second potential) are offset from each other with respect to the main surface of at least one of the pair of substrates SUB1 and SUB2. In other words, the shown pixel structure of the present embodiment is such that the pixel electrode PX has

an area which is not opposed to the counter electrode CT in the thickness direction of the liquid crystal layer LC, while the counter electrode CT also has an area which is not opposed to the pixel electrode PX in the thickness direction. Accordingly, the pixel structure of the present embodiment differs from that of a so-called TN (Twisted Nematic) type of liquid crystal display device in which the entire area of the pixel electrode PX is opposed to the counter electrode (also called a common electrode) in the thickness direction of the liquid crystal LC.

Symbol RU denotes the grain contained in the resin PRS which constitutes the columnar spacer SP, symbol DL (d1, d2) the video signal line, symbol CT (g1) the counter electrode, symbol PX (g2) the pixel electrode, and symbol AOF an insulating layer made of an aluminum oxide film. In case that the counter electrode CT, the scanning signal line GL, the scanning electrode GT and the like all of which are covered with the insulation layer (also called a gate insulating film) GI are formed of a single layer of aluminum or an alloy thereof, the aluminum oxide film AOF is needed to avoid the electrical short circuit between any of these electrodes and lines and any of the image signal line DL, the source drain electrodes SD1 and SD2 and the pixel electrode PX all of which are formed over the insulation layer GI. However, the aluminum oxide film AOF is not needed in case that the signal lines and the electrodes all of which are covered with the insulation layer GI are formed by stacking, for example, a thin film of aluminum or an alloy thereof on a thin film of chromium (Cr), or are formed of a material other than aluminum. The above parenthesized signs d1, d2, g1 and g2 denote conductor layers which form the above-described wiring (signal lines).

POL1 and POL2 denote polarizers which are respectively disposed on the outsides of the pair of substrates SUB1 and SUB2.

The columnar spacer SP has a structure in which the resin PRS contains the grains RU having nearly the same size as the cell gap. The material of the grains RU may have a spherical or elliptical spherical shape such as that of a silica bead, a polymer bead or the like, or a non-spherical (non-elliptical) shape like a short-fiber shape. In addition, the material of the grains RU is not limited to transparent grains, and may also be black grains.

Since the grains RU are contained in the columnar spacer SP, the desired cell gap can be ensured owing to the grains RU of the columnar spacer SP even if the height of the portion of the resin PRS which constitutes the columnar spacer SP is smaller than the cell gap. Accordingly, the cell gap becomes uniform, and a display screen of uniform brightness can be obtained.

In addition, since the mechanical characteristic of the grains RU is added to the mechanical characteristic of the columnar spacer SP, it is possible to obtain a spacer having a mechanical characteristic similar to a spherical spacer.

In the present embodiment, as shown in Fig. 2, the columnar spacer SP is formed on the side of the color filter substrate (the other substrate SUB2), but it may also be formed on the side of the active matrix substrate (the other substrate SUB1).

As shown in Fig. 1, the columnar spacer SP is arranged to cover the area (the hatched area of Fig. 1) between the video signal line DL and the counter electrode CT.

In the present embodiment, as shown in Fig. 1, the number of columnar spacers SP per pixel is six, and the number of grains RU contained in each of the columnar spacers SP is seven. This is one example, and both of these numbers are determined arbitrarily. Although the six columnar spacers SP are arranged nearly at equal intervals, this arrangement is not limitative, and they may also be arranged in a staggered or random form.

The plan shape of the columnar spacer SP is not limited to the approximate square shown in Fig. 1, and may also be other shapes such as circle, ellipse and diamond.

Furthermore, the columnar spacer SP needs only to contain one or more grains RU, and if the columnar spacer SP is made to contain plural grains RU, it is preferable that the number of grains RU per unit area of the plane shape of the columnar spacer SP be made approximately uniform and the dispersion density be also made approximately uniform.

According to this embodiment, it is possible to prevent undesirable light leak from the area between the video signal line DL and the counter electrode CT. The reason for this advantage will be described below.

The liquid crystal LC exists only in a portion between the video signal line DL and the counter electrode CT. That is to say, in a peripheral portion of the pixel (in the present embodiment, between the video signal line DL and the counter electrode CT adjacent thereto), the liquid crystal LC exists only in a portion where the columnar spacer SP is absent. The liquid crystal LC is driven to change the light transmittance. Accordingly, as an area where the liquid crystal LC is present becomes smaller in the peripheral portion of the pixel, an area whose light transmittance changes by the behavior of the liquid crystal LC in this portion also becomes smaller, whereby the amount of light transmittance from between the video signal line DL and the counter electrode CT is decreased.

Accordingly, as compared with a case in which the columnar spacers SP are absent, it is possible to reduce the required value of the optical density of the black matrix BM. Moreover, if the dielectric constant or the electric conductivity of the columnar spacer SP is higher than that of the liquid crystal LC, an electric field can more readily be formed around the columnar spacer SP than around the liquid crystal LC.

Accordingly, owing to the electric field between these electrodes (the video signal line DL and the counter electrode CT), the liquid crystal LC becomes difficult to drive. For this reason, light shielding can readily be effected even in a portion where the columnar spacers SP are absent.

Referring to Figs. 1 and 2, the right and left ends of the pixel of the present embodiment are defined by the respective counter electrodes CT adjacent to the video signal lines DL on the side of the substrate SUB1. From this fact, it is apparent that the present invention can be applied to a TN type of liquid crystal display device or the like in which pixel electrodes and counter electrodes are respectively formed over the substrate SUB1 and the substrate SUB2 by using a high-light-transmittance (hereinafter, transparent) material such as ITO (Indium-Tin-Oxide) and in such a manner as to be opposed to each other across the liquid crystal LC, and it is also apparent that it is possible to achieve the above-described effects even in such a TN type of liquid crystal display device. In other words, regarding both ends of the pixel electrode provided for each pixel on the side of the substrate SUB1 over which thin film transistors are formed as the side of the counter electrode CT facing the adjacent video signal line DL in the present embodiment, it is possible to obtain the above-described light shielding effect by disposing the columnar spacers SP of the present embodiment in such a manner as to cover the areas between the respective ends of the pixel electrode and the video signal lines. Moreover, if the gap between each of the video signal lines and the opposed counter electrode (also called a common electrode, in the TN type liquid crystal display device) is determined with the grains RU of the columnar spacers SP, the thickness of the liquid crystal (called, a cell gap) can be kept uniform over the entire display area of the liquid crystal display device.

Accordingly, from the viewpoint of the light shield effect, it is preferable for embodying the present invention that the spacers SP being formed by dispersing in the material (resin) PRS the grains RU smaller in elasticity or softer than this material should be formed over the substrate SUB1 to cover at least the areas interposed between the ends of the pixel electrode and the opposed video signal lines so as to determine the gap between the substrate SUB1 and the opposed substrate SUB2 (the cell gap) by the size of the above-described grains (in the case of grains of approximately spherical shape, the spherical diameter thereof). The grains RU and the material PRS, whether organic or inorganic, need only to satisfy the above-described relationship. It is recommended that the material PRS use a material which works as a binder for the grains RU to be dispersed therein.

On the other hand, from the viewpoint of the uniformalization of the cell gap, it is preferable for embodying the present invention that the above-described spacers should be formed over the substrate SUB1 to cover the video signal lines or over the substrate SUB2 to oppose the video signal lines. Referring to Fig. 2 by way of example, the bottom end portion of the grain disposed at a portion of a main surface of the substrate SUB2 being opposite to the above-described video signal line (refer to the central grain RU in Fig. 2) may be close to the upper surface of the substrate SUB1 opposite to the substrate SUB2 (the surface of the orientation film ORI1, as the uppermost one of the plural layers stacked over the main surface of the substrate SUB1) with respect to the grains disposed in the other portions (refer to the right and left grains RU in Fig. 2). From another viewpoint, the spacer includes at least a first portion thereof covering one of a plurality of signal lines being disposed on the main surface of the substrate and a second portion thereof covering an area between this signal line and the electrodes for applying driving voltage to the liquid crystal layer being adjacent to this

signal line, and a thickness of the spacer at the first portion is determined by at least one of the grains being dispersed in the first portion. Contrarily, in case that the columnar spacer SP is formed over the main surface of the substrate SUB1, the top end portion of the grain formed over the video signal line may be close to the lower surface of the substrate SUB2 opposite to the substrate SUB1 (the surface of the orientation film ORI2, as the uppermost one of the plural layers stacked over the main surface of the substrate SUB2 when the substrate SUB2 shown in Fig. 2 is turned upside down) with respect to the grains disposed in the other portions.

In any of the viewpoints, some of the grains RU being contained in the above-described spacer SP and determining the cell gap keep either top or bottom end thereof in contact with the upper surface of one substrate (including the stacked matter formed over the main surface thereof) being opposite to the other substrate over which the spacer SP is formed. On the other hand, the others of the grains RU and the upper surface of the one substrate form gaps therebetween. As illustrated in the present embodiment, in case that the spacer SP is formed over the substrate SUB2, the spacer SP may be disposed on the overcoat layer OC for reducing the unevenness appearing a plurality of color filters. From a similar viewpoint, in case that the spacer SP is formed over the substrate SUB1, the spacer SP may be disposed on the protective layer PSV having the effect of reducing the unevenness appearing between signal lines or pixels. In addition, the orientation film ORI1 or ORI2 is formed over the uppermost surface of at least either one of the substrates SUB1 and SUB2. As in the present embodiment, in case that the spacer SP is covered with the orientation film ORI2 provided over the substrate SUB2 on which the spacer SP is formed, the orientation film ORI2 is interposed between the grain which determines the cell gap (in Fig. 2, the central grains RU) and the orientation film ORI1 which constitutes the uppermost layer of the substrate

SUB1. However, the positional relationship between the orientation film ORI1 and the bottom end portions of this grain (determining the cell gap) and the other grains (in Fig. 2, the right and left grains) is as described previously, and the gap appearing between the latter grains and the orientation film ORI1 is larger. This fact occurs even in case that the spacer SP is formed on the upper portion of the substrate SUB1 and is covered with the orientation film ORI1.

In a so-called simple matrix type liquid crystal display device in which a group of plural stripe-shaped transparent electrodes is provided over one of a pair of substrates thereof, and another group of plural stripe-shaped transparent electrodes extending in the direction intersecting the group of transparent electrodes is provided over another of the pair of substrates, spacers according to the present embodiment may be provided between the stripe-shaped transparent electrodes belonging to either one of the groups of transparent electrodes.

In case that the present invention is applied to a TN type liquid crystal display device or a simple matrix type liquid crystal display device instead of the present embodiment, the above-described spacers SP should be arranged to be opposite to the black matrix BM. Even if the spacers SP partly cover the counter electrodes CT (in the present embodiment), pixel electrodes (in the TN type liquid crystal display device) or the end portions of stripe-shaped transparent electrodes (in the simple matrix type liquid crystal display device) in the peripheral portions of pixels, no image display is impaired because these portions are opposed to the black matrix BM.

Since the resin which constitutes the spacer SP generally uses an ultraviolet rays hardening photosensitive resin, the above-described dielectric constant and electric conductivity characteristics are difficult to control to their desired values. In the present embodiment, the electrical characteristics of the entire columnar spacer SP is controlled

by using the electrical characteristics of the grains RU contained in the columnar spacer SP.

In case of making the dielectric constant and the electric conductivity of the columnar spacer SP larger than those of the liquid crystal, for example, carbon black or metal particulates are incorporated into the grains RU to be used or are made to adhere to the surfaces thereof.

Incidentally, in the present embodiment, the columnar spacers SP are formed over the color filter substrate (the substrate SUB2), but may also be formed over the active matrix substrate (the substrate SUB1) as described previously.

According to the present embodiment, contrast and brightness are improved and the occurrence of crosstalk is prevented, whereby it is possible to obtain a liquid crystal display device having performance for displaying a high quality image.

Fig. 3 is a plan view schematically illustrating the construction of the essential portion of the vicinity of a pixel of a liquid crystal panel constituting a lateral electric field type active matrix liquid crystal display device as a second embodiment of the liquid crystal display device according to the present invention. In Fig. 3, reference signs identical to those shown in Fig. 1 correspond to identical functional portions.

Unlike the first embodiment in which a plurality of columnar spacers SP are formed between adjacent pixels, in the present embodiment, a bank-shaped columnar spacer is formed at each region between adjacent pixels. The other construction is similar to that of the first embodiment.

Specifically, the columnar spacer SP is formed in a bank-like shape in the area between the video signal line DL and the counter electrode CT being positioned in the portion between adjacent pixel areas in each of which the pixel electrode PX is disposed. The grains RU contained in the columnar spacer SP are uniformly dispersed by

approximately the same number per unit area. In addition, it is preferable that the dispersion density of the grains RU should be uniform in the whole area of the columnar spacer SP.

Even with this embodiment, it is possible to prevent undesirable light leak from the area between the video signal line DL and the counter electrode CT. The reason for this advantage is as described previously in connection with the first embodiment. Similarly to the first embodiment, the present embodiment can be applied to the TN type liquid crystal display device and the simple matrix type liquid crystal display device and can achieve such advantages as mentioned above.

A fabrication method for the liquid crystal display device according to the present invention, i.e., an embodiment of a forming method for the columnar spacer SP, will be described below.

Fig. 4 is a schematic cross-sectional view illustrating a first example of a transfer sheet for forming a columnar spacer, and illustrates the fabrication method for the liquid crystal display device according to the present invention.

Symbol TFS denotes a transfer sheet, and either a photosensitive transfer sheet having a photosensitive resin layer PRS in which silica grains RU are uniformly dispersed and arrayed being stacked on a base film BSF, or a thermal transfer sheet having a thermodeposital resin layer TRS in which the silica grains RU are dispersed and arrayed being stacked on the base film BSF is used for the transfer sheet in this embodiment.

Fig. 5 is a schematic cross-sectional view illustrating a second example of a transfer sheet for forming a columnar spacer, and illustrates the fabrication method for the liquid crystal display device according to the present invention.

A transfer sheet TFS is a photosensitive transfer sheet having the photosensitive resin layer PRS in which the silica grains RU are dispersed and arrayed at the required locations, i.e., in only portions to be shaped into the columnar spacers SP, being stacked on the base film BSF, or a thermal transfer sheet having the thermo-fusible adherent resin layer TRS in which the silica grains RU are dispersed and arrayed at only the required locations being stacked on the base film BSF.

Fig. 6 is a schematic cross-sectional view illustrating a third example of a transfer sheet for forming a columnar spacer, and illustrates the fabrication method for the liquid crystal display device according to the present invention.

The transfer sheet TFS is a photosensitive transfer sheet having the photosensitive resin layer PRS in which the silica grains RU are uniformly dispersed and arrayed being stacked via a separation layer SEPL, or a thermal transfer sheet having the thermo-fusible adherent resin layer TRS in which the silica grains RU are dispersed and arrayed being stacked on the base film BSF via a thermo-fusion/adhesion preventing layer ATAL.

The fabrication method for the liquid crystal display device according to the present invention using the above-described transfer sheet TFS will be described below.

Figs. 7A to 7D are schematic process diagrams illustrating a first embodiment of a fabrication method for a color filter substrate, inclusive of a columnar-spacer forming method using the photosensitive transfer sheet described above with reference to Fig. 4, and the first embodiment is processed in the order of Steps (A) to (D) as follows.

(A) A black photosensitive resin is applied to the substrate SUB2 of a glass substrate having a thickness of 0.7 mm or 1.1 mm, and is exposed via a photomask (exposure mask) having a predetermined aperture pattern which corresponds to the

layout pattern of a black matrix, developed and calcined, for forming the black matrix BM thereby.

Then, the steps of exposure, development and calcination similar to the above-described steps are repeated with photosensitive red, green and blue resins, for forming respective color filters FIL (a red-colored layer FIL(R), a green-colored layer FIL(G) and a blue-colored layer FIL(B)) sequentially thereby.

A protective layer (leveling layer) OC is deposited to cover the upper portion of the color filter FIL formed in this manner. (Regarding the above steps, refer to Fig. 7A).

Then, the photosensitive transfer sheet TFS having the photosensitive resin layer PRS in which the silica grains RU are dispersed and arrayed being stacked on the base film BSF is stuck to the protective layer OC. At this time, the photosensitive transfer sheet TFS is stuck to the protective layer OC so that the photosensitive resin layer PRS of the photosensitive transfer sheet TFS is fixed to the protective layer OC.

(B) After the photosensitive resin layer PRS has been stuck to the protective layer OC, the base film BSF is peeled so that only the photosensitive resin layer PRS is left on the protective layer OC. (Refer to Fig. 7B.)

(C) The photosensitive resin layer PRS is irradiated with ultraviolet rays via a photomask PMSK having an aperture pattern corresponding to positions at which the columnar spacers SP will be formed (in this step, immediately above the black matrix BM). In this step, the photosensitive resin is assumed to be of a negative type in which a portion irradiated with ultraviolet rays is hardened, but a photosensitive resin of a positive type in which a portion irradiated with ultraviolet rays is removed by development can also be used. In this case, a photomask having an aperture pattern which corresponds to portions other than positions at which to form the columnar

spacers SP. (Refer to Fig. 7C.)

(D) After exposure, the unexposed portions of the photosensitive resin layer PRS are removed by development, and the columnar spacers SP in each of which the silica grains RU are dispersed and arrayed are formed by calcination. (Refer to Fig. 7D.)

Incidentally, although the above description has referred to an example using the photosensitive transfer sheet shown in Fig. 4, a fabrication method using the photosensitive transfer sheet shown in Fig. 5 or 6 is also similar to the above-described fabrication method. However, in case that the photosensitive transfer sheet shown in Fig. 5 is used, it is necessary to make alignment of positions at which to form the columnar spacers SP and positions at which to disperse the grains RU of the photosensitive transfer sheet. In case that the photosensitive transfer sheet shown in Fig. 6 is used, the process of peeling the base film BSF after the photosensitive resin layer PRS is stuck to the protective layer OC is facilitated.

According to the present embodiment, it is possible to improve the mechanical strength of the columnar spacers for uniformalizing the cell gap, and it is possible to accurately and readily form the columnar spacers.

Figs. 8A to 8D are schematic process diagrams illustrating a second embodiment of the fabrication method for the color filter substrate, inclusive of a columnar-spacer forming method using the photosensitive transfer sheet described above with reference to Fig. 4, and the second embodiment is processed in the order of Steps (A) to (D) similar to Figs. 7A to 7D. The present embodiment differs from the first embodiment described above with reference to Figs. 7A to 7D in the handling of the base film which constitutes the photosensitive transfer sheet.

(A) The substrate SUB2 is a glass substrate having a thickness of 0.7 mm or

1.1 mm, and a black photosensitive resin is applied to the substrate SUB2 and is exposed via a photomask (exposure mask) having a predetermined aperture pattern which corresponds to the layout pattern of a black matrix, developed and calcined, for forming the black matrix BM thereby.

Then, the steps of exposure, development and calcination similar to the above-described steps are repeated with photosensitive red, green and blue resins, thereby sequentially forming the color filter FIL (the red-colored layer FIL(R), the green-colored layer FIL(G) and the blue-colored layer FIL(B)).

The protective layer (leveling layer) OC is deposited to cover the upper portion of the color filter FIL formed in this manner. (Regarding the above steps, refer to Fig. 8A).

Then, the photosensitive transfer sheet TFS having the photosensitive resin layer PRS in which the silica grains RU are dispersed and arrayed being stacked on the base film BSF is stuck to the protective layer OC. At this time, the photosensitive transfer sheet TFS is stuck to the protective layer OC so that the photosensitive resin layer PRS of the photosensitive transfer sheet TFS is fixed to the protective layer OC. This step is similar to the embodiment shown in Fig. 7A.

(B) After the photosensitive resin layer PRS has been stuck to the protective layer OC, the base film BSF is left thereon without being peeled. (Refer to Fig. 8B.)

(C) The photomask PMSK having an aperture pattern which corresponding to positions at which the columnar spacers SP will be formed (in this step, immediately above the black matrix BM) is stacked on the base film BSF of the photosensitive transfer sheet TFS, and the photosensitive resin layer PRS is irradiated with ultraviolet rays via the photomask PMSK. In this step, the photosensitive resin is assumed to be of a negative type in which a portion irradiated with ultraviolet rays is hardened, but a

photosensitive resin of a positive type in which a portion irradiated with ultraviolet rays is removed by development can also be used, as described above. (Refer to Fig. 8C.)

In the embodiment described above with reference to Fig. 7C, the photomask PMSK needs to be held a predetermined distance away from the photosensitive resin layer PRS by using arbitrary means. In contrast, in the present embodiment, since the method of stacking the photomask PMSK directly on the base film BSF is adopted, it is possible to acurately set the gap between the photomask PMSK and the photosensitive resin layer PRS by changing the thickness of the base film BSF.

(D) After exposure, the base film BSF is peeled and the unexposed portions of the photosensitive resin layer PRS are removed by development, and the columnar spacers SP in each of which the silica grains RU are dispersed and arrayed are formed by calcination. (Refer to Fig. 8D.)

Incidentally, even if the photosensitive transfer sheet shown in Fig. 5 or 6 is used, the columnar spacers SP can be formed by a similar process.

According to the present embodiment, it is possible to improve the mechanical strength of the columnar spacers for uniformalizing the cell gap, and it is possible to accurately and readily form the columnar spacers.

Figs. 9A and 9B are schematic process diagrams illustrating a third embodiment of the fabrication method for the color filter substrate, inclusive of a columnar-spacer forming method using the thermal transfer sheet described above with reference to Fig. 4. In the present embodiment, the steps of forming the black matrix BM, the three-color filters FIL (FIL(R), FIL(G), FIL(B)) and the protective layer OC over the substrate SUB2 are similar to those of each of the above-described embodiments, and therefore, the illustration and description of the same steps are omitted.

In Step (A) of Fig. 9A, a thermal transfer sheet TTFS is stuck to the protective layer OC of the color filter substrate SUB2 over which the color filter and the like are formed in the above-described manner. In the thermal transfer sheet TTFS, a thermodeposital resin TRS in which the silica grains RU are dispersed is stacked on the base film BSF. This thermal transfer sheet TTFS is disposed on the protective layer OC with the thermodeposital resin TRS being opposed to the protective layer OC.

Then, on the side of the base film BSF, a thermal head TH is made to abut on each position at which to form a columnar spacer, whereby the position is heated. The present embodiment adopts the method of sequentially heating each position at which to form a columnar spacer, while moving the thermal head TH as indicated by arrows in Fig. 9A with the color filter substrate SUB2 being fixed. However, the thermal transfer sheet TTFS and the color filter substrate SUB2 may also be moved with the thermal head TH being fixed. In this case, by adjusting the amount of feeding of the thermal transfer sheet TTFS, it is possible to prevent residues of the thermodeposital resin TRS from occurring as shown in (B) of Fig. 9B. This is preferable in terms of a reduction in the material cost of the thermal transfer sheet TTFS.

Incidentally, this heating method using a thermal head is not limitative, and a method of irradiating predetermined locations with heating radiation such as laser light may also be adopted.

In this step, the thermodeposital resin TRS of the thermal transfer sheet TTFS which lies at each position at which to form the columnar spacer is thermally fused to the protective layer OC.

After the thermodeposital resin TRS which lies at each position at which to form the columnar spacer has been fused to the protective layer OC, the columnar spacers SP are formed by peeling the thermal transfer sheet TTFS from the color filter

substrate SUB2 (B).

According to this embodiment, the processing of forming the columnar spacers SP is simplified because there is no need for a photolithographic process such as the method described above with reference to Figs. 7A to 7D or Figs. 8A to 8D.

Although the embodiment shown in Figs. 9A and 9B uses, as a transfer sheet, the thermal transfer sheet shown in Fig. 4, the thermal transfer sheet shown in Fig. 5 or 6 can be used similarly to the above-described one.

The active matrix substrate SUB1 can be fabricated by a process similar to the known process of forming a thin film transistor. This active matrix substrate SUB1 uses a glass substrate having a thickness of 0.7 mm or 1.1 mm, and deposition and patterning are repeated over this substrate. Thus, thin film transistors TFT made of amorphous silicon AS, and storage capacitances Cstg as well as electrode groups such as pixel electrodes PX, source electrodes SD1 and counter electrodes CT are formed. In addition, plural video signal lines DL, plural drain electrodes SD2 and plural counter voltage signal lines CL for applying predetermined voltages to the above-described electrodes via thin film transistors TFT as well as plural scanning signal lines GL and plural gate electrodes GT all of which control the thin film transistors TFT are formed in a grid-like form.

The thin film transistors TFT as well as the above-described electrode groups and lines are covered with the insulation layers GI and the protective layers PSV. After that, an alignment layer material is applied and calcined and the alignment layer is given a liquid crystal alignment control function by a rubbing treatment or a photoalignment treatment, thereby forming the orientation control film ORI1.

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The substrate SUB1 fabricated in the above-described manner and the color

filter substrate SUB2 fabricated in the above-described embodiment are assembled to oppose each other, and the peripheral portion of the assembly is fixed with an adhesive material, excluding a liquid crystal filling port. Liquid crystal compounds are sealed between the two substrates, and the liquid crystal filling port is sealed with an end-sealing material.

After that, the gap between the two substrates is defined with the columnar spacers by a press, whereby a liquid crystal display device having a predetermined cell gap is obtained.

Driving means and a specific product example of a liquid crystal display device to which the present invention is applied will be described below.

Fig. 10 is a schematic explanatory view illustrating the driving means for a liquid crystal display device to which the present invention is applied. The liquid crystal display device has an image display portion formed by an assembly of plural pixels arrayed in matrix form, and each of the pixels is constructed to be able to individually modulate and control transmitted light from a back light (not shown) arranged at the back of the liquid crystal display device.

The scanning signal lines GL, the counter voltage signal lines CL and the video signal lines DL are formed over an effective pixel area AR of the active matrix substrate SUB1 which is one constituent element of the liquid crystal display device. The scanning signal lines GL and the counter voltage signal lines CL are disposed to be extended in the x direction (the row direction) of the effective pixel area AR and to be juxtaposed in the y direction (the column direction) of the same. The video signal lines DL are insulated from both the scanning signal lines GL and the counter voltage signal lines CL, and are disposed to be extended in the y direction and to be juxtaposed in the x direction.

A unit pixel is formed in each of the rectangular areas surrounded by the scanning signal lines GL, the counter voltage signal lines CL and the image signal lines DL.

The liquid crystal display device is provided with a vertical scanning circuit V and a video signal driving circuit H as its external circuits. A scanning signal (voltage) is sequentially supplied to each of the scanning signal lines GL by the vertical scanning circuit V, and in synchronism with that timing, a video signal (voltage) is supplied to the video signal lines DL from the video signal driver circuit H.

Each of the vertical scanning circuit V and the video signal driving circuit H is supplied with electric power from a liquid crystal driving power supply circuit 3, and image information from a CPU 1 is separated into display data and a control signal and inputted to the circuits V and H by a controller 2.

Fig. 11 is an explanatory view showing one example of driving waveforms of the liquid crystal display device to which the present invention is applied. In Fig. 11, a counter voltage is formed as an alternating current rectangular wave having two values VCH and VCL, and the non-selection voltage of each scanning signal VG(i - 1) and VG(i) is varied between two values VCH and VCL at intervals of one scanning period in synchronism with the counter voltage. The amplitude of the counter voltage and the amplitude of the non-selection voltage are made the same.

A video signal voltage is a voltage obtained by subtracting 1/2 of the amplitude of the counter voltage from a voltage to be applied to the liquid crystal layer.

The counter voltage may also be a direct current voltage, but by forming the counter voltage as an alternating current voltage, it is possible to decrease the maximum amplitude of the video signal voltage, whereby it is possible to use a video signal driver circuit (signal-side driver) of low breakdown voltage.

Fig. 12 is a developed perspective view illustrating the entire construction of the liquid crystal display device according to the present invention, and illustrates a specific structure of the liquid crystal display device (hereinafter referred to as a liquid crystal module: MDL which integrally includes two substrates SUB1 and SUB2, driving means, a back light and other constituent members).

Symbol SHD denotes a shield case made of a metal sheet (also called a metal frame), symbol WD a display window, symbols INS1 to INS3 insulating sheets, symbols PCB1 to PCB3 circuit boards which constitute the driving means (PCB1 is a drain-side circuit board: a video signal line driving circuit board, PCB2 is a gate-side circuit board, and PCB3 is an interface circuit board), symbols JN1 to JN3 joiners which electrically connect the circuit boards to one another, symbols TCP1 and TCP2 tape carrier packages, symbol PNL a liquid crystal panel, symbol GC a rubber cushion, symbol ILS a light shielding spacer, symbol PRS a prism sheet, symbol SPS a diffusing sheet, symbol GLB a light guide plate, symbol RFS a reflecting sheet, symbol MCA a lower case (mold frame) which is formed by integral molding, symbol MO an aperture of the lower case MCA, symbol LP a fluorescent tube, symbol LPC a lamp cable, symbol GB a rubber bush which supports the fluorescent tube LP, symbol BAT a double-sided adhesive tape, and symbol BL a back light made of a fluorescent tube, a light guide plate or the like. The liquid crystal module MDL is assembled by stacking diffusing plate members in the shown layered arrangement.

The liquid crystal module MDL has two kinds of housing·holding members, the lower case MCA and the shield case SHD, and the metal-made shield case SHD in which the insulating sheets INS1 to INS3, the circuit boards PCB1 to PCB3 and the liquid crystal panel PNL are fixedly housed is combined with the lower case MCA in which the back light BL made of the fluorescent tube LP, the light guide plate GLB, the

prism sheet PRS and the like are housed.

An integrated circuit chip for driving each pixel of the liquid crystal panel PNL is mounted on the video signal line driving circuit board PCB1, and an integrated circuit chip for receiving a video signal and a control signal such as a timing signal from an external host, a timing converter TCON which processes timing and generates a clock signal and the like are mounted on the interface circuit board PCB3.

The clock signal generated by the aforesaid timing converter is supplied to the integrated circuit chip mounted on the video signal line driving circuit board PCB1 via a clock signal line CLL which is formed in the interface circuit board PCB3 and the video signal line driving circuit board PCB1.

Each of the interface circuit board PCB3 and the video signal line driving circuit board PCB1 is a multilayer printed circuit board, and the clock signal line CLL is formed as an internal layer line of the interface circuit board PCB3 and the video signal line driving circuit board PCB1.

The drain-side circuit board PCB1, the gate-side circuit board PCB2 and the interface circuit board PCB3 for driving TFTs are connected to the liquid crystal panel PNL by the tape carrier packages TCP1 and TCP2, and these circuit boards are connected to one another by the joiners JN1, JN2 and JN3.

The liquid crystal panel PNL is a lateral electric field type of liquid crystal display device according to the above-described present invention, and is provided with the aforesaid columnar spacers of the above-described embodiments for maintaining the gap between the two substrates at a predetermined value.

Fig. 13 is a perspective view of a notebook type computer which is one example of electronic equipment in which a liquid crystal display device according to the present invention is mounted.

This notebook type computer (portable personal computer) is made of a keyboard block (body block) and a display block which is joined to the keyboard block by a hinge. The keyboard block houses signal generating functions such as a keyboard, a host (host computer) and a CPU. The display block has the liquid crystal panel PNL, and the driving circuit boards PCB1 and PCB2, the PCB3 provided with the control chip TCON, and an inverter power supply board which is a back light power supply are mounted in the peripheral portion of the liquid crystal panel PNL.

In addition, the liquid crystal module described above with reference to Fig. 12, which is integrally provided with the liquid crystal panel PNL, the various kinds of circuit boards PCB1, PCB2 and PCB3, the inverter power supply board and the back light, is mounted in the notebook type computer.

Incidentally, the above embodiments have been described with reference to a construction in which the present invention is applied to a so-called lateral electric field type of liquid crystal display device, but the present invention is not limited to this construction and, as a matter of course, can similarly be applied to another type of liquid crystal display device whose cell gap needs to be kept uniform, because grains are contained in spacers.

As described above, according to the present invention, since columnar spacers are arrayed between video signal lines and counter electrodes or arrayed to cover the areas between the vide signal lines and pixel electrodes and grains of the substantially same size as a cell gap are contained in the columnar spacers, the cell gap in the display screen can be uniformly formed so that the brightness of the display screen becomes uniform.

In addition, since the liquid crystal in the area between each of the electrodes is partly eliminated, light transmitted through the area between each of the electrodes is

not easily affected by an electric field formed between these electrodes.

Accordingly, the amount of light leak from the area becomes small, and contrast and brightness are improved, and the occurrence of crosstalk is prevented, whereby it is possible to obtain a liquid crystal display device capable of displaying a high quality image.

While we have shown and described several embodiments in accordance with the present invention, it is understood that the same is not limited thereto but is susceptible of numerous changes and modifications as known to those skilled in the art, and we therefore do not wish to be limited to the details shown and described herein but intend to cover all such changes and modifications as are encompassed by the scope of the appended claims.

WHAT IS CLAIMED IS:

1. A liquid crystal display device comprising:

a liquid crystal panel having a pair of substrates at least one of which is transparent, a black matrix having a plurality of openings and being formed over one of the pair of substrates, at least two or more kinds of color filters having different colors from each other for displaying a color image and being formed at the plurality of openings of the black matrix respectively, a group of electrodes formed over at least one of the pair of substrates, a liquid crystal layer having dielectric anisotropy and being interposed between the pair of substrates, and an orientation control layer for aligning a molecular orientation of liquid crystal compounds constituting the liquid crystal layer in a predetermined direction; and

driving means for applying driving voltages to the electrode groups,

wherein at least one of the pair of substrates are spaced from one another by columnar spacers made of a resin in which grains having a size approximately equal to a thickness of the liquid crystal layer is approximately uniformly dispersed.

2. A liquid crystal display device according to claim 1, wherein a diameter of the grains being contained in the columnar spacers is smaller than the thickness of the liquid crystal layer at a central portion of a pixel of the liquid crystal panel being defined by the opening of the black matrix.

3. A liquid crystal display device according to claim 1, wherein a dielectric constant or an electric conductivity of the columnar spacers is higher than that of liquid crystal compounds constituting the liquid crystal layer, and each of the columnar spacers is formed in a portion between the signal line and a common line which are disposed at a position hidden by the black matrix.

4. A method of fabricating a liquid crystal display device which includes: a liquid crystal panel having a pair of substrates at least one of which is transparent, at least two or more kinds of color filters of different colors for displaying a color display being formed over one of the pair of substrates, a black matrix spacing the color filters, a group of electrodes including signal lines and common lines all of which are formed over another of the pair of substrates, a liquid crystal layer having dielectric anisotropy and being interposed between the pair of substrates being opposed to one another with a predetermined gap, an orientation control layer for aligning a molecular orientation of the liquid crystal layer in a predetermined direction, and columnar spacers of a resin in which grains having a size approximately equal to a predetermined thickness of the liquid crystal layer is dispersed with uniform density and which are formed over at least one of the pair of substrates; a pair of polarizers being stacked on the respective substrates so as to intersect polarizing axes thereof with one another; and driving means for applying driving voltages to the group of electrodes,

comprising steps of:

sticking a photosensitive transfer sheet having a photosensitive resin layer stacked over a surface of a base film to one of the pair of substrates, by opposing the photosensitive resin layer to the one of the pair of substrates, the photosensitive resin layer containing grains having sizes approximately equal to the predetermined gap; and

exposing the photosensitive resin layer via a mask having an aperture pattern corresponding to positions at which the columnar spacers will be formed, developing the photosensitive resin layer, and removing an unexposed portion of the photosensitive resin layer leaving an exposed portion thereof on the one of the pair of substrates, so as to form the columnar spacers of a resin in which grains having sizes approximately equal to a thickness of the liquid crystal layer are approximately uniformly dispersed.

5. A method of fabricating a liquid crystal display device which includes: a liquid crystal panel having a pair of substrates at least one of which is transparent, at least two or more kinds of color filters of different colors for displaying a color display being formed over one of the pair of substrates, a black matrix spacing the color filters, a group of electrodes including signal lines and common lines all of which are formed over another of the pair of substrates, a liquid crystal layer having dielectric anisotropy and being interposed between the pair of substrates opposed to each other with a predetermined gap, an orientation control layer for aligning a molecular orientation of the liquid crystal layer in a predetermined direction, and columnar spacers made of a resin in which grains having sizes approximately equal to a desired thickness of the liquid crystal layer is dispersed with uniform density, the columnar spacers being formed over at least one of the pair of substrates: a pair of polarizers being stacked on the respective substrates so as to intersect polarizing axes thereof with each other; and driving means for applying driving voltages to the electrode groups,

comprising steps of:

sticking a thermal transfer sheet having a thermodeposital resin layer stacked over a surface of a base film to one of the pair of substrates, by opposing the thermodeposital resin layer to the one of the pair of substrates, the thermodeposital resin layer containing grains having sizes approximately equal to the predetermined gap; and

heating certain portions of the thermal transfer sheet selectively corresponding to positions at which the columnar spacers will be formed, fusing only the heated portions of the thermodeposital resin layer to the one of the pair of substrates, and removing the thermal transfer sheet together with unheated portions of the thermodeposital resin layer from the one of the pair of substrates, so as to form the columnar spacers each made of a resin in which grains each having a size approximately

equal to a thickness of the liquid crystal layer is approximately uniformly dispersed.

6. A liquid crystal display device comprising:

a pair of substrates comprising a first substrate having a first main surface and a second substrate having a second main surface being arranged by opposing main surfaces thereof to one another with a predetermined gap therebetween;

a liquid crystal layer being interposed between the pair of substrates;

a plurality of signal lines being formed over the first main surface;

a plurality of electrodes being formed over the first main surface and constituting a plurality of pixels respectively, each of which is connected to one of the plurality of signal lines for receiving a voltage to be applied to the liquid crystal layer;

a plurality of spacers being disposed between the first and second main surfaces for keeping the predetermined gap thereby, each of the plurality of spacers is formed of a first material in which a plurality of grains being formed of a second material are dispersed;

wherein each of the plurality of spacer includes a first portion covering one of the plurality of signal lines and a second portion covering an area between the one of the plurality of signal lines and one of the plurality of electrodes adjacent thereto, at least one of the grains being dispersed in the first portion determines a thickness of the spacer at the first portion.

7. A liquid crystal display device according to claim 6, wherein the first material has a smaller in elasticity or softer than the second material.

8. A liquid crystal display device according to claim 6, wherein the plurality of spacers are formed over the second main surface and the first potion in each of the plurality of spacers is opposed to one of the plurality of signal lines.

9. A liquid crystal display device according to claim 6, wherein at least one of the grains being dispersed in the first portion in each of the plurality of spacers is in contact with the uppermost surface of layers being stacked on one of the first and second main surfaces of the pair of substrates being opposite to the plurality of spacers.

10. A liquid crystal display device according to claim 9, wherein the plurality of spacers are covered by an orientation film being formed over another of the first and second main surfaces, and the at least one of the grains in the first portion in each of the plurality of spacers is in contact with the uppermost one of layers being stacked on the one of the first and second main surfaces via the orientation film.

11. A liquid crystal display device according to claim 6, further comprising at least one electrode being formed over the second main surface and being opposite to at least one of the plurality of electrodes.

12. A liquid crystal display device according to claim 6, further comprising at another group of electrodes being formed over the first main surface, each of which is disposed in one of the plurality of pixels, and the one of the plurality of electrodes constituting the one of the plurality of pixels is positioned between the one of the plurality of signal lines adjacent to the one of plurality of electrodes and one of the another group of electrode being disposed in the one of the plurality of pixels.

ABSTRACT OF THE DISCLOSURE

For preventing brightness irregularity of a display screen of a liquid crystal display device due to non-uniformity of a gap between a pair of substrate thereof for interposing a liquid crystal layer: a cell gap, and also for preventing a decrease in brightness and occurrence of crosstalk therein, the present invention uses a transfer sheet formed of a resin PRS in which grains RU having sizes defining a preferable cell gap are dispersed being stacked on a base film for fabrication process of the liquid crystal display device, and provides columnar spacers SP containing the grains RU over a surface of either a color filter substrate or an active matrix substrate of the liquid crystal display device by transferring the resin PRS to the substrate.